Farmers' Climate Change Risk Perceptions: an Application of the Exchangeability Method

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Research Questions

1. **Do farmers perceive risks related to climate change?**

2. **Do beliefs about climate change affect risk perceptions?**

3. **Are there any other factors influencing risk perceptions?**

Research Motivations

- Quantifying farmers' risk perceptions and investigating affecting factors is critical
  - Explaining farmers' willingness to implement adaptation and mitigation
  - Developing and improving outreach programs
- In previous literature:
  - reliance on qualitative methods (e.g., Likert type scales)
  - focus on magnitude of perceived risk and not on probability of events

Our contribution to literature

- Quantification of short run (2011) and long run (2013) risk perception of apple and grape farmers in Trentino using the Exchangeability method that allows
  - to take both magnitude and probability into account
  - without asking subjects to make difficult probability statements or complete likelihood scales

Considered Hazards (1)

Focus on key crop loss hazards whose gravity is predicted to increase with climate change

Hail precipitations:

- Main cause of revenue losses
- An increase in gravity and frequency is directly linked to more extreme weather conditions

Considered Hazards (II)

Powdery mildew:

- fungal disease that affects grapes
- a growing threat as temperatures increase and rain becomes scarcer

Apple dieback:

- condition where apple trees die prematurely
- a growing threat as extreme winter conditions become more frequent

Survey design

- Preliminary focus group to identify
  - how farmers naturally express damages
  - the time reference for the long run (2031)
- In spring 2011 we interviewed 195 farmers
  - 120 operating apple orchards
  - 75 operating grape vineyards
- Computer-assisted-personal-interviews on
  - **risk perceptions elicited via the exchangeability method**
  - beliefs regarding climate change
  - farm and farmer characteristics
  - historical farm crop losses

Exchangeability Method

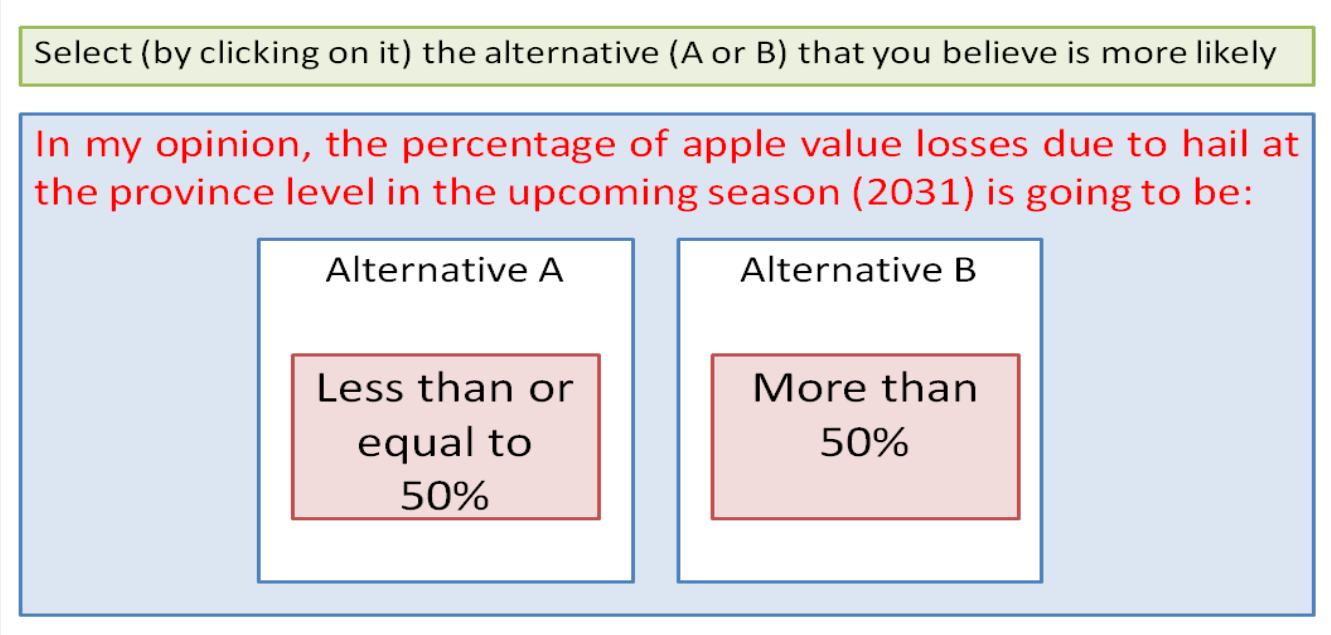
(Baillon A., *Decision Analysis* 2008)

Express your opinion by providing the following guesses (assessments) regarding the hail damage to apple cultivation in the Trento province as a percentage of the value of the apple production in the current agronomic year (2011)

Minimum damage	%
Maximum damage	%

Exchangeability Method

- Subjects choose between prospects that consist of two disjoint intervals of the event space.



- Choices are iterative, disjoint intervals are adjusted based on prior answer, until indifference.
- **Indifference identifies the median damage (our farmer-specific measure of risk perceptions).**

Risk Perceptions

- Each farmer went through the EM 4 times (2 perils x 2 time references)
  - upcoming growing season 2011: Short-run perceptions
  - future growing season, **2031: Long-run perceptions**
- We use long-run perceptions to investigate whether farmers have quantitatively detectable perceptions of risks related to climate change

- NB: We elicit risk perceptions for crop losses at the province-level and not at individual farm to avoid confounding factors

Elicited Values

Median damage *(Average values across farmers)*

Risk type	Unit of measure	Short Run 2011	Long Run 2031
Hail	% apple value loss	21.17	**26.24**
Hail	% grape value loss	12.68	**18.65**
Dieback	% apple trees affected	10.47	**11.74**
Powdery Mildew	% grape bunches affected	10.12	**13.27**

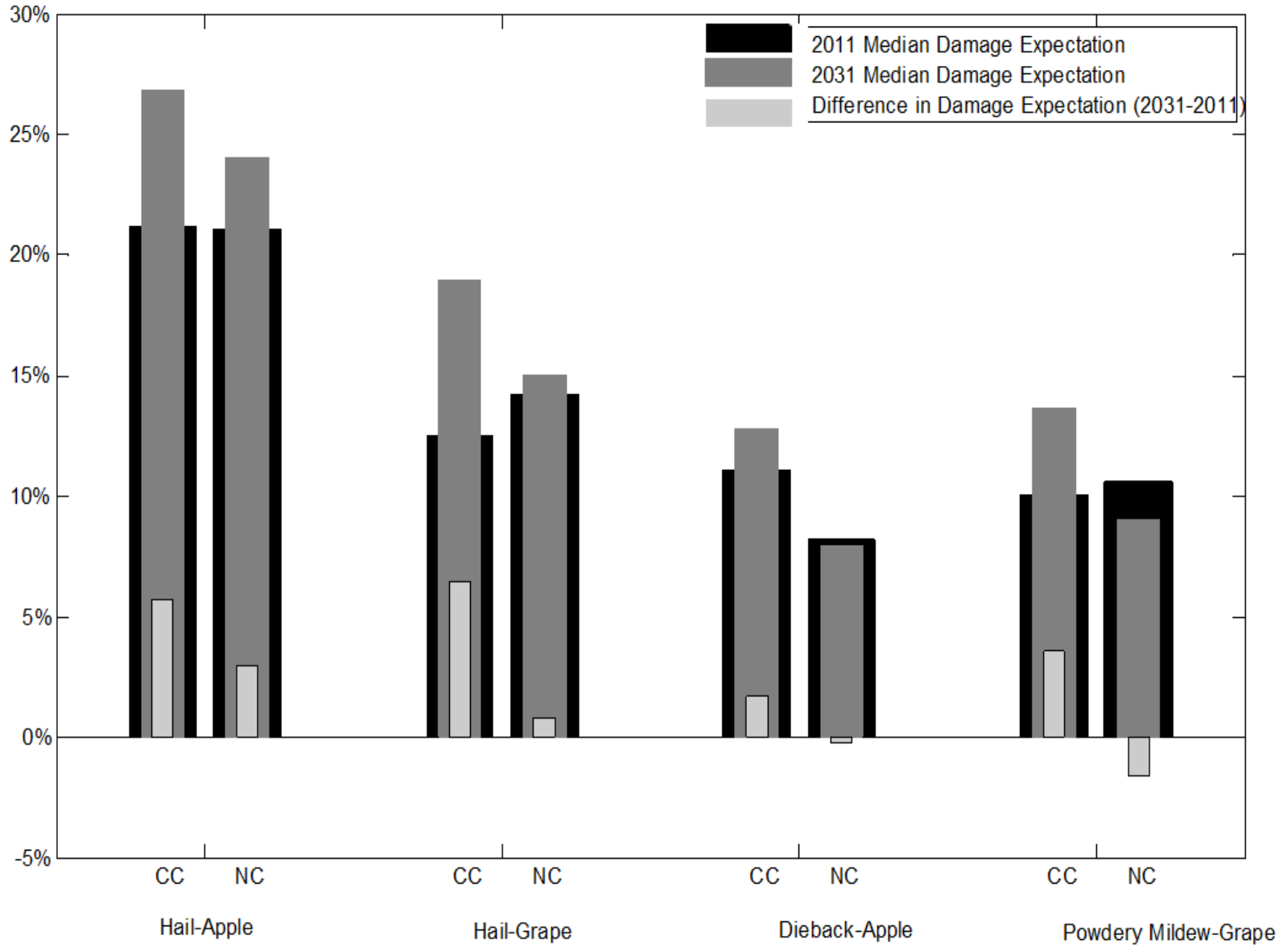
General Beliefs on Climate Change

Do you believe that climate is changing?

83% Yes

	%
Due to natural factors exclusively	5.6
Due predominantly to natural factors	14.2
Due to a similar extent to natural and human activity factors	58.0
Due predominantly to human activity factors	19.1
Due to human activity factors exclusively	3.1

Risk perceptions according to beliefs



Regression models

Variable	Farmers' 2031-2011 Median Province Damage Expectations			
	Apple Hail	Grape Hail	Apple Dieback	Grape Powdery Mildew
Age	-0.046	-0.036	0.042	-0.077
	(0.100)	(0.074)	(0.088)	(0.095)
Climate Change Belief	3.161*	3.802**	2.478*	5.902
	(1.648)	(1.716)	(1.377)	(4.268)
Cultivated/Owned	0.012	-0.003	0.020	0.045
	(0.029)	(0.028)	(0.035)	(0.038)
Education	0.002	1.236***	-0.130	0.518
	(0.357)	(0.405)	(0.384)	(0.405)
Farm Size	-0.492	-0.168	0.375	-0.464
	(0.341)	(0.316)	(0.250)	(0.311)
Farming Experience	-0.069	0.149*	0.024	0.086
	(0.094)	(0.085)	(0.084)	(0.081)
Full Time	0.236	-1.213	0.314	-0.403
	(2.067)	(1.767)	(2.398)	(2.266)
Household Size	-0.408	-0.180	0.328	-0.621
	(0.777)	(0.552)	(0.776)	(0.845)
Income	0.941	0.089	0.532	1.782
	(0.737)	(0.759)	(0.684)	(1.237)
Liquidity	0.571	-0.146	-3.957	-3.443*
	(2.238)	(1.638)	(2.411)	(1.964)

Regression models (ctd)

Variable	Farmers' 2031-2011 Median Province Damage Expectations			
	Apple Hail	Grape Hail	Apple Dieback	Grape Powdery Mildew
Damage Experience [a]	3.480*	2.561*	3.364*	4.085**
	(1.841)	(1.435)	(1.805)	(1.619)
Probability Test Score	1.111*	0.826**	1.039*	1.511***
	(0.655)	(0.373)	(0.620)	(0.504)
Coop Member	-0.685	0.624	-2.248	3.482
	(2.404)	(3.400)	(2.471)	(4.361)
Coop Representative	1.326	-1.952	1.697	1.998
	(1.759)	(1.806)	(1.459)	(2.808)
Co.Di.Pr.A	2.904*	1.645	2.010	0.092
	(1.652)	(1.555)	(1.633)	(2.130)
Sessions & Articles	-0.279	0.581	-0.573*	0.442
	(0.407)	(0.378)	(0.291)	(0.393)
Constant	-0.191	-17.573**	-7.508	-20.695*
	(7.926)	(7.337)	(7.389)	(10.580)
R-Squared	0.159	0.490	0.164	0.348

Note: *, **, *** denote 10%, 5%, and 1% significance levels, respectively. Stdev in parenthesis.

[a] For the Apple Hail and Grape Hail regression this explanatory variable is past experience with hail damage. For Apple Dieback and Grape Powdery Mildew this variable is past experience with damage from that peril.

Qualitative measures

"On a scale from -5 (strong decline) to +5 (strong increase) in damage, how will climate change affect the average damage due to hail change in the future (2031)?"

Qualitative changes in expected average damage at the province level in the long-run (2031)

Risk Type	Obs.	Mean	StdDev
Hail-Apples	120	1.28	1.86
Hail-Grapes	75	1.49	1.36
Dieback-Apples	120	1.34	1.85
Powdery Mildew-Grapes	75	1.48	1.84

Risk Type	CC Believers	CC Non-Believers	Difference
Hail-Apples	1.43	0.77	0.65*
	(0.20)	(1.43)	
Hail-Grapes	1.55	0.83	0.72*
	(0.17)	(0.31)	
Dieback-Apples	1.59	0.48	1.10***
	(0.20)	(0.25)	
Powdery Mildew-Grapes	1.55	0.67	0.88
	(0.23)	(0.49)	

Conclusions

- Farmers who believe in climate change have higher quantitative perceptions of future hazards to their farming operations that are directly (hail) or indirectly (crop disease susceptibility) related to climate change
- From a policy perspective:
  - provide support for a "segmented approach to outreach with farmers" (Arbuckle et al. 2013) that takes into account farmers' beliefs about climate change.
  - the key role of first-hand experience suggests the opportunity to use "field days" to increase farmers' awareness of climate change risks.
- From a methodological perspective:
  - further research is needed to address the suitability and consistency of the various risk perception elicitation methods

Thank you for you attention

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