O' Sole Mio
An Experimental Analysis of Weather and Risk Attitudes

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Motivation

1. Economics Literature: personal characteristics and risk attitudes
   - Cox and Harrison (2008) measuring risk aversion;
   - Benjamin, Choi, and Fisher (2010): Protestants more risk-averse than Catholics.
   - Men less risk averse than women (Eckel and Grossman, 2007 for a comprehensive survey.
   - Lower risk aversion for younger (Dohmen et al., 2010) and wealthier (Guiso and Paiella, 2008) individuals.

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2. Finance Literature: weather affects assets' prices
   - Saunders (1993), Hirshleifer and Shumway (2003): stock returns are negative when cloudy in city where stocks are exchanged.
   - Kamstra, Kramer, and Levi (2003) seasonal variations in stock returns are correlated with variations in the exposure to sunlight of different countries.
   - Lo and Wu (2010) analyst forecasts are more pessimistic in the fall.

Weather, mood, and risks taking

1. Psychology Literature: impact of sunlight and weather on human mood:
   - Sanders and Brizzolara, 1982: good mood & low levels of humidity;
   - Cunnigham, 1979; Parrot and Sabini, 1990; and Schwartz and Clore, 1983: good mood & high levels of sunlight;
   - Cunnigham, 1979; Howarth and Hoffman, 1984: good mood & high temperature.

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2. Mechanism: what is the process by which mood affects human behavior?
   - *Cognitive evaluation channel*: Mood $\rightarrow$ cognitive behavior $\rightarrow$ decision making (Isen, 2000);
   - *Risk tolerance channel*: Mood $\rightarrow$ risk preferences (link between anxiety/depression and "sensation seeking" measures - proxy for risk-taking behavior-. (Eisenberg et al., 1998)).

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3. Our approach: Explicit link between sunlight/weather on risk attitudes
   - Controlled laboratory experiments in which subjects are randomized between sessions with good and bad weather.
   - Subjects are presented with sets of lottery pairs to elicit their risk attitude.

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- Within-subjects treatments
  - Payoff treatments (High/Low);
  - Tasks treatments (Risk/Skewness/Risk+Skewness).

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- First, subjects ran the three tasks treatments with low payoffs first, and then with high payoffs.
- Last, subjects were asked to complete a questionnaire.

Questionnaire

- Age, Gender, Marital status, Employment status
- Income: Personal income, Family income
- Education: Major, year, highest education of parents
- Voting: vote cast in last election, intention to vote in next
- Risky actions: gambling, playing lotteries
- Religion
- Political leaning:
- Happiness
- Weather: today and tomorrow

Defining Weather

We use three definitions/measures:

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   - → Precipitation more than average is bad weather
3. Subjective Assessment
   - → How do you feel about the Weather?

Baseline treatment

- Multiple Price Listing
- Baseline Holt & Laury, 2002 treatments (with 1x payoffs)

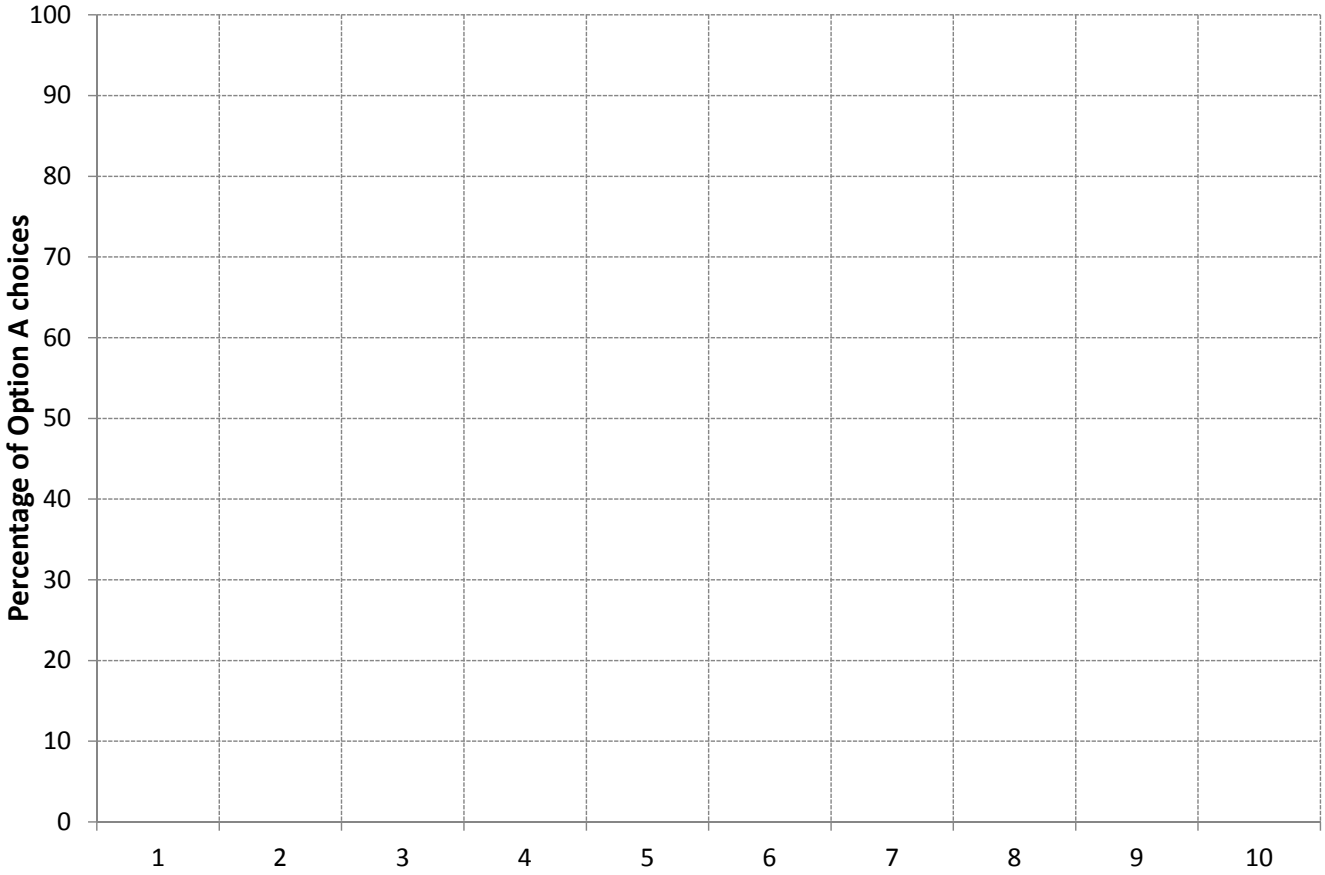
Holt & Laury, 2002 MPL

	Option A	Option B
Decision 1 :	\$2.00 w.p 10% , \$1.60 w.p 90%	\$3.85 w.p 10% , \$0.10 w.p 90%
Decision 2 :	\$2.00 w.p 20% , \$1.60 w.p 80%	\$3.85 w.p 20% , \$0.10 w.p 80%
Decision 3 :	\$2.00 w.p 30% , \$1.60 w.p 70%	\$3.85 w.p 30% , \$0.10 w.p 70%
Decision 4 :	\$2.00 w.p 40% , \$1.60 w.p 60%	\$3.85 w.p 40% , \$0.10 w.p 60%
Decision 5 :	\$2.00 w.p 50% , \$1.60 w.p 50%	\$3.85 w.p 50% , \$0.10 w.p 50%
Decision 6 :	\$2.00 w.p 60% , \$1.60 w.p 40%	\$3.85 w.p 60% , \$0.10 w.p 40%
Decision 7 :	\$2.00 w.p 70% , \$1.60 w.p 30%	\$3.85 w.p 70% , \$0.10 w.p 30%
Decision 8 :	\$2.00 w.p 80% , \$1.60 w.p 20%	\$3.85 w.p 80% , \$0.10 w.p 20%
Decision 9 :	\$2.00 w.p 90% , \$1.60 w.p 10%	\$3.85 w.p 90% , \$0.10 w.p 10%
Decision 10 :	\$2.00 w.p 100% , \$1.60 w.p 0%	\$3.85 w.p 100% , \$0.10 w.p 0%

Moments

	Option A				Option B			
	Exp	Var	Skew	Kurt	Exp	Var	Skew	Kurt
Decision 1 :	1.64	0.01	2.67	8.11	0.48	1.27	2.67	8.11
Decision 2 :	1.68	0.03	1.50	3.25	0.85	2.25	1.50	3.25
Decision 3 :	1.72	0.03	0.87	1.76	1.23	2.95	0.87	1.76
Decision 4 :	1.76	0.04	0.41	1.17	1.60	3.38	0.41	1.17
Decision 5 :	1.80	0.04	0.00	1.00	1.98	3.52	0.00	1.00
Decision 6 :	1.84	0.04	-0.41	1.17	2.35	3.38	-0.41	1.17
Decision 7 :	1.88	0.03	-0.87	1.76	2.73	2.95	-0.87	1.76
Decision 8 :	1.92	0.03	-1.50	3.25	3.10	2.25	-1.50	3.25
Decision 9 :	1.96	0.01	-2.67	8.11	3.48	1.27	-2.67	8.11
Decision 10 :	2.00	0.00	-	-	3.85	0.01	-	-

Average Risk Aversion



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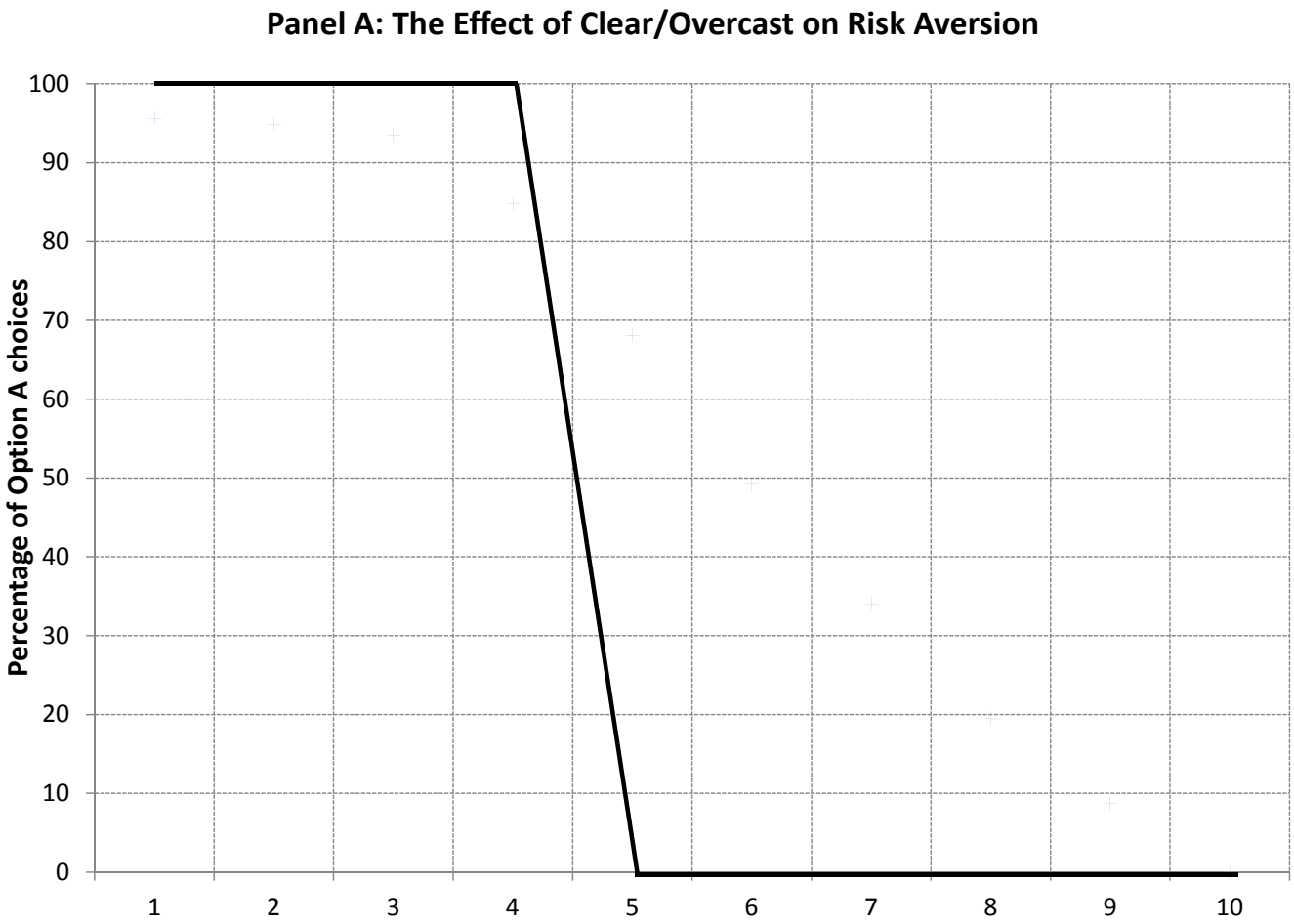

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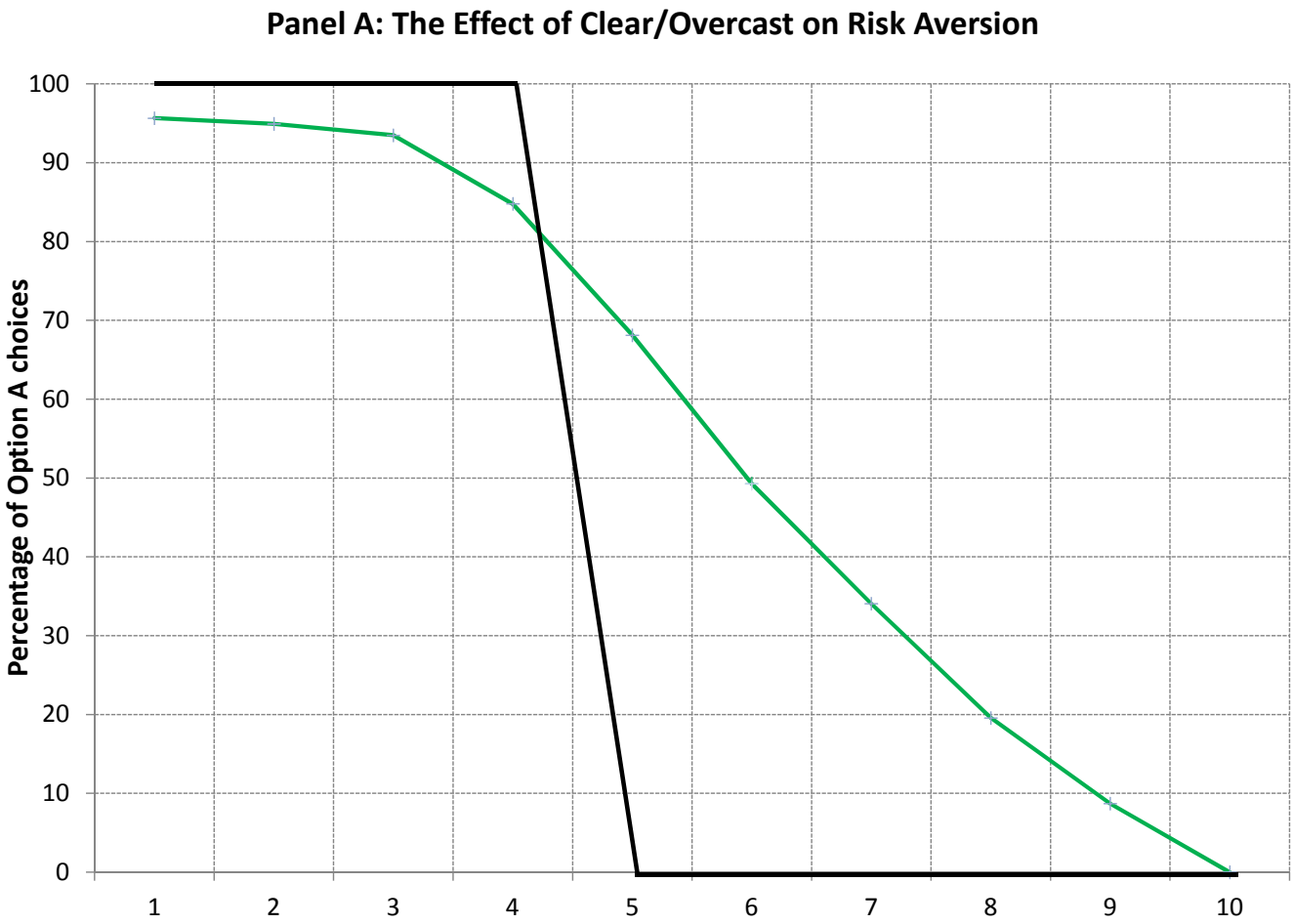

Amount of Sunlight and Risk Aversion

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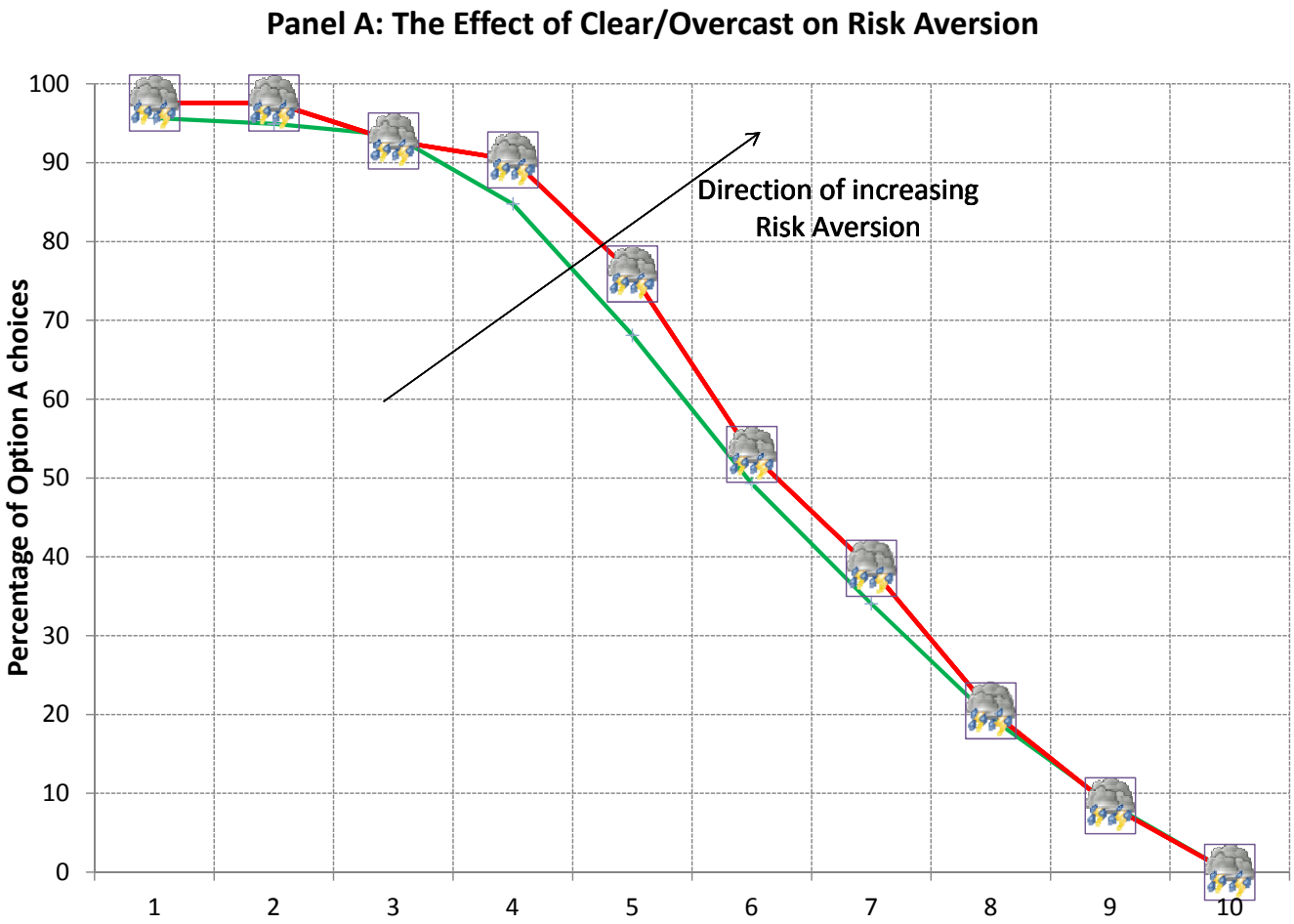

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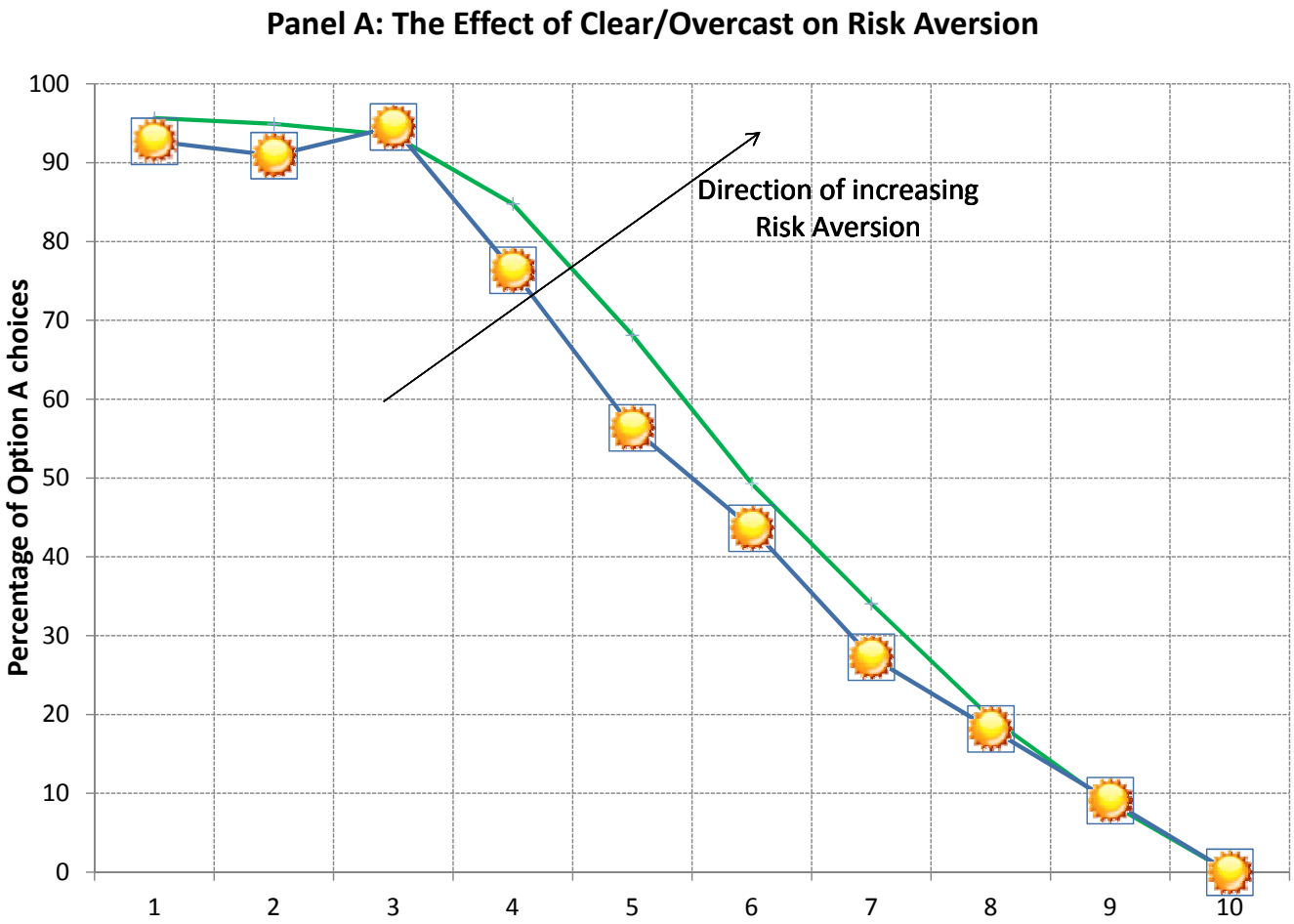

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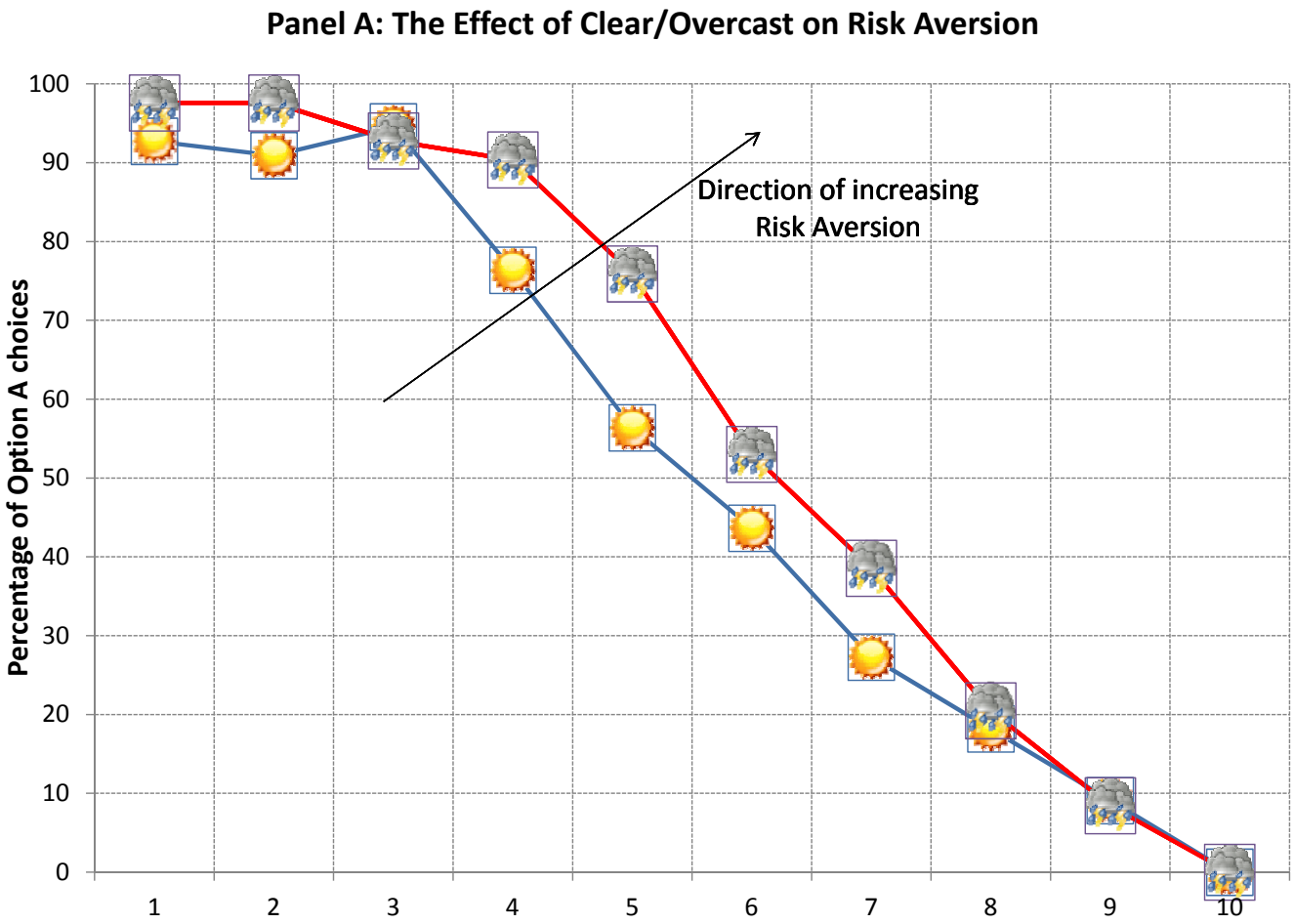

Precipitation and Risk Aversion

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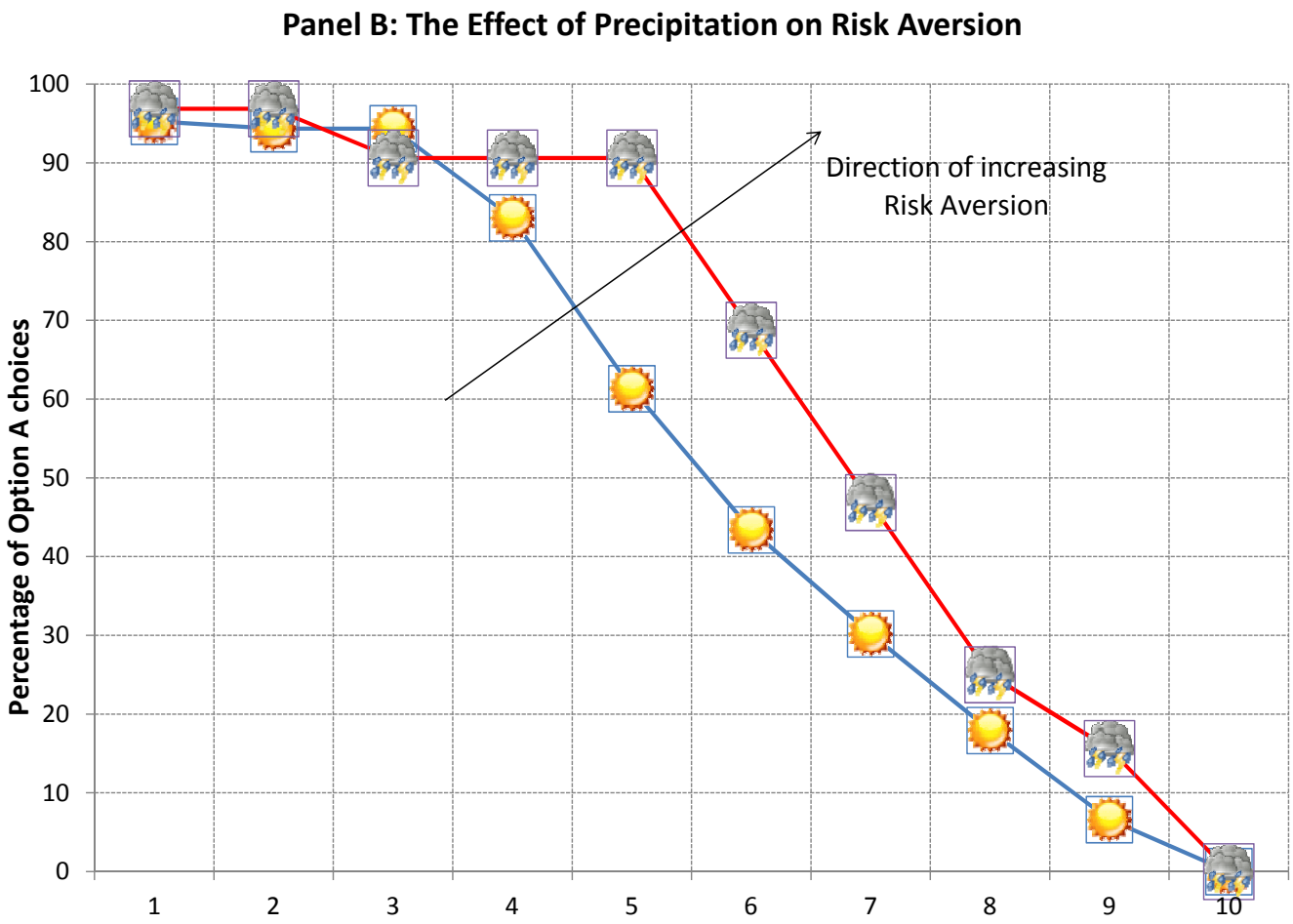

Subjective Weather and Risk Aversion

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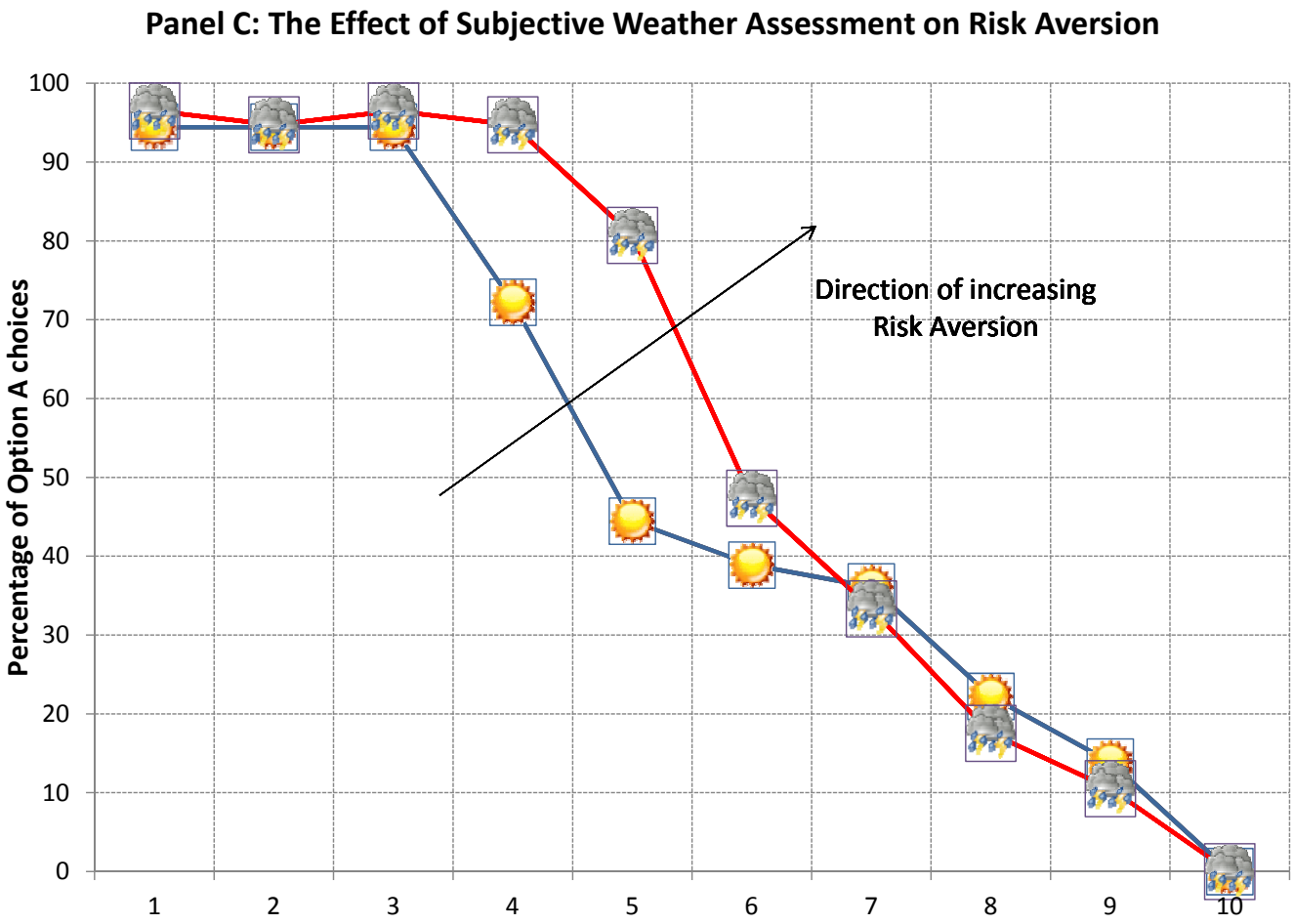

Are these differences statistically significant?

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Table: Average Frequencies of Safe Choices

	Clear/Overcast	**Precipitation**	**Subjective Weather**
Bad Weather	0.575	0.622	0.572
Good Weather	0.509	0.526	0.511
$[p-values]$	[0.008]	[0.001]	[0.035]

What is the marginal effect of weather?

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- Control for weather and other personal characteristics
  - Religiousness
  - Sex
  - Political Leaning
  - Wealth
  - Race
  - ...

Logit - Risk Aversion

	One variable at a time	Precipitation + controls	Overcast-Clear + controls	Subjective Weather + controls
Precipitation	0.080^{***}	0.080^{***}		
Overcast-Clear	0.052^{***}		0.051^{***}	
Subjective Weather (Bad-Good)	0.054^{***}			0.051^{***}
Income	0.000	0.000	0.000^{*}	0.000
Religious (Yes-No)	-0.068^{**}	0.000	-0.044^{*}	-0.046^{*}
Political Leaning (Liberal-Conservative)	0.029^{*}	0.000	0.053^{**}	0.054^{**}
Gender (Male-Female)	0.026			
Race				
White/Caucasian	-0.090^{***}			
Asian	0.027			
Play lotteries (Yes-No)	0.000			
Economy concerned (No-Yes)	-0.024^{*}			

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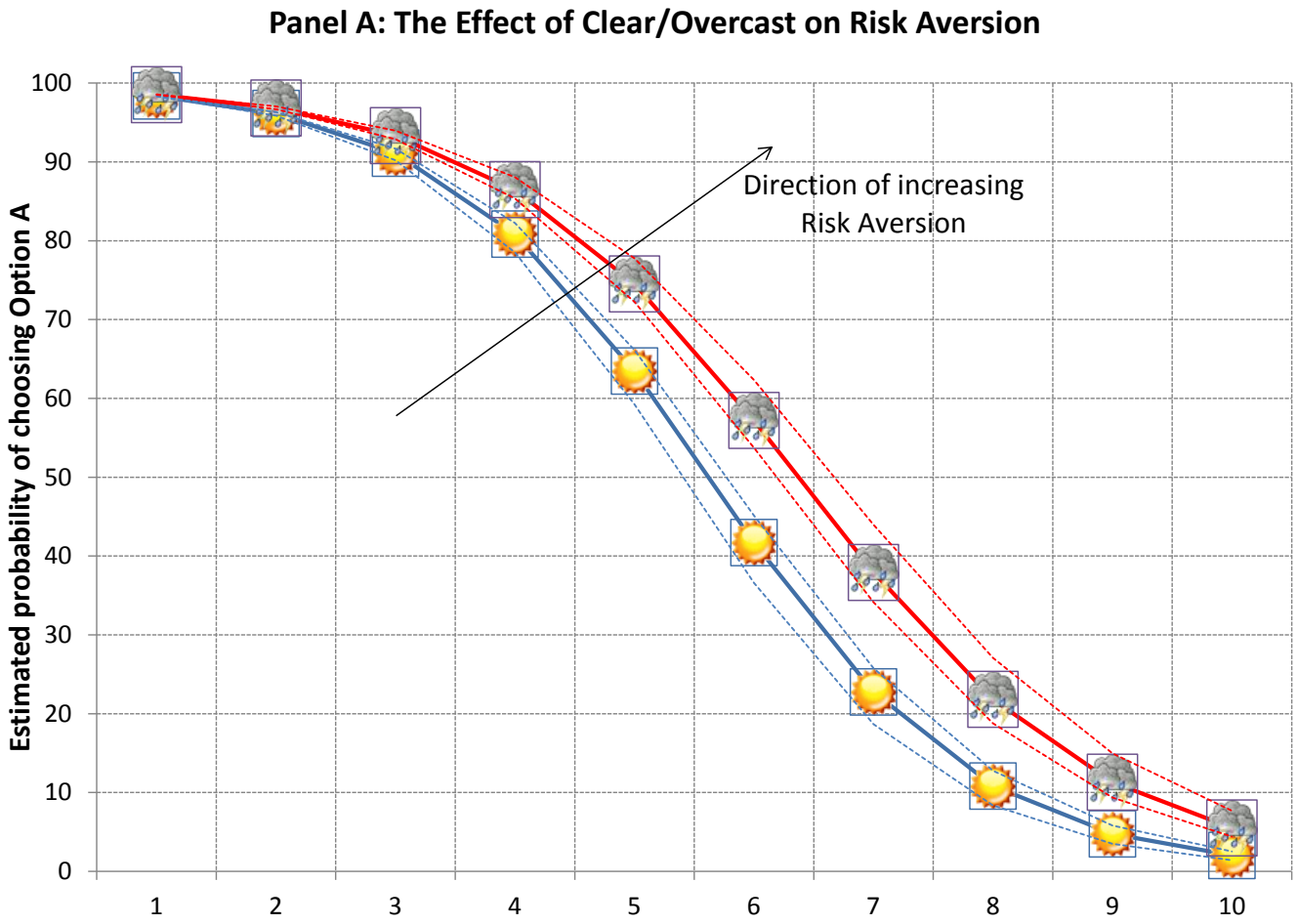

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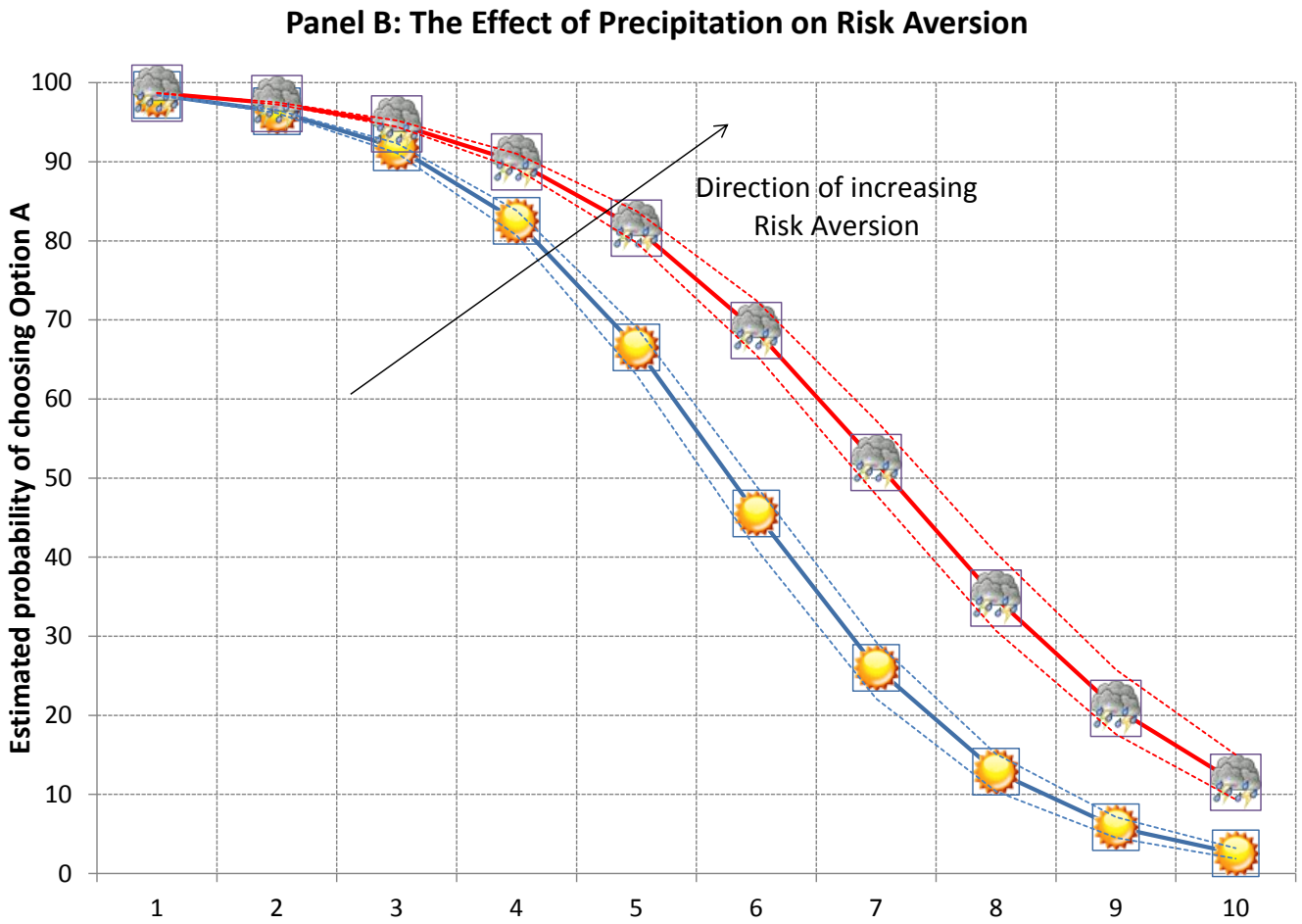

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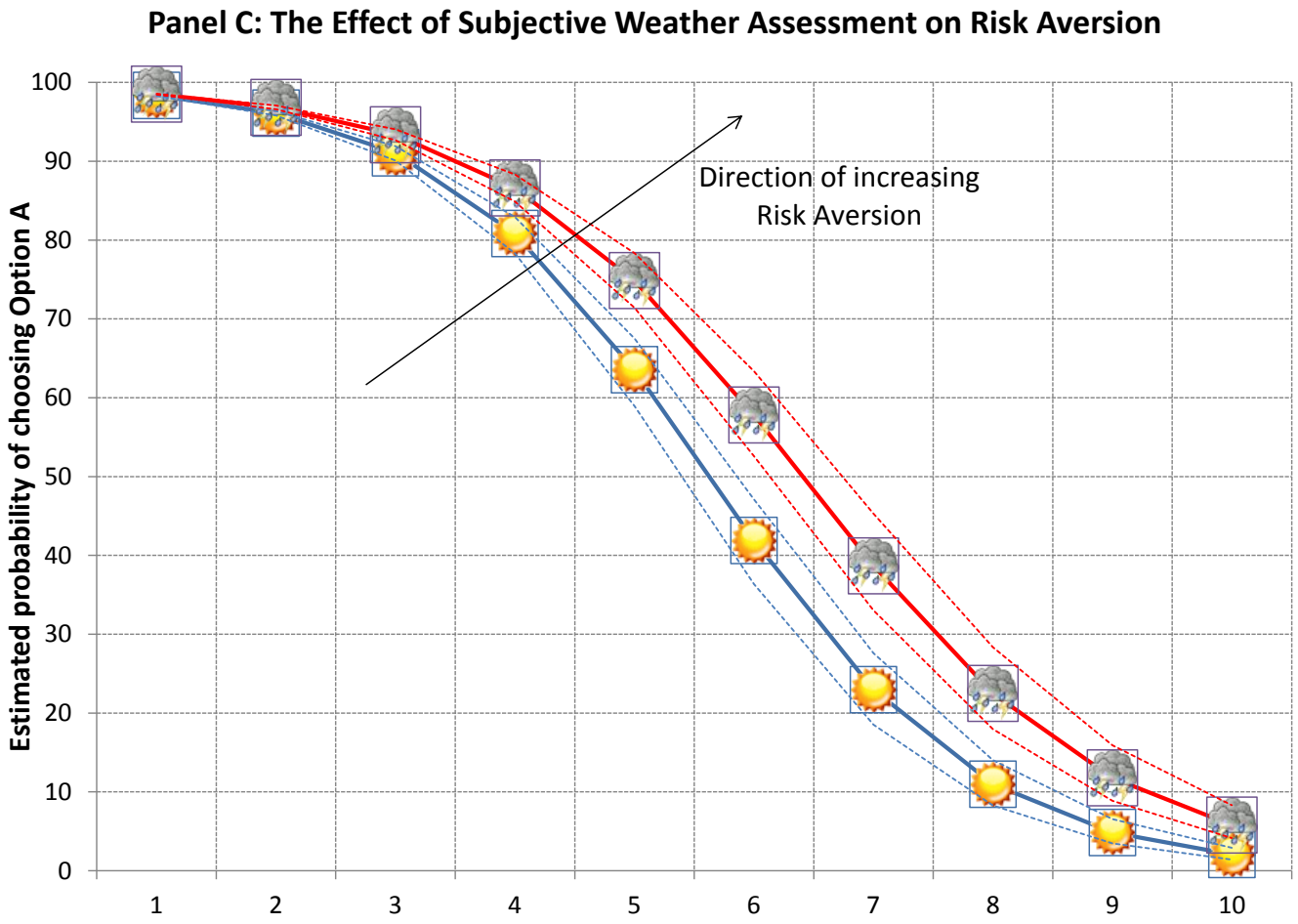

High Payoffs

- What happen when the stakes are higher?
- Subjects repeat the task with 10x payoffs.

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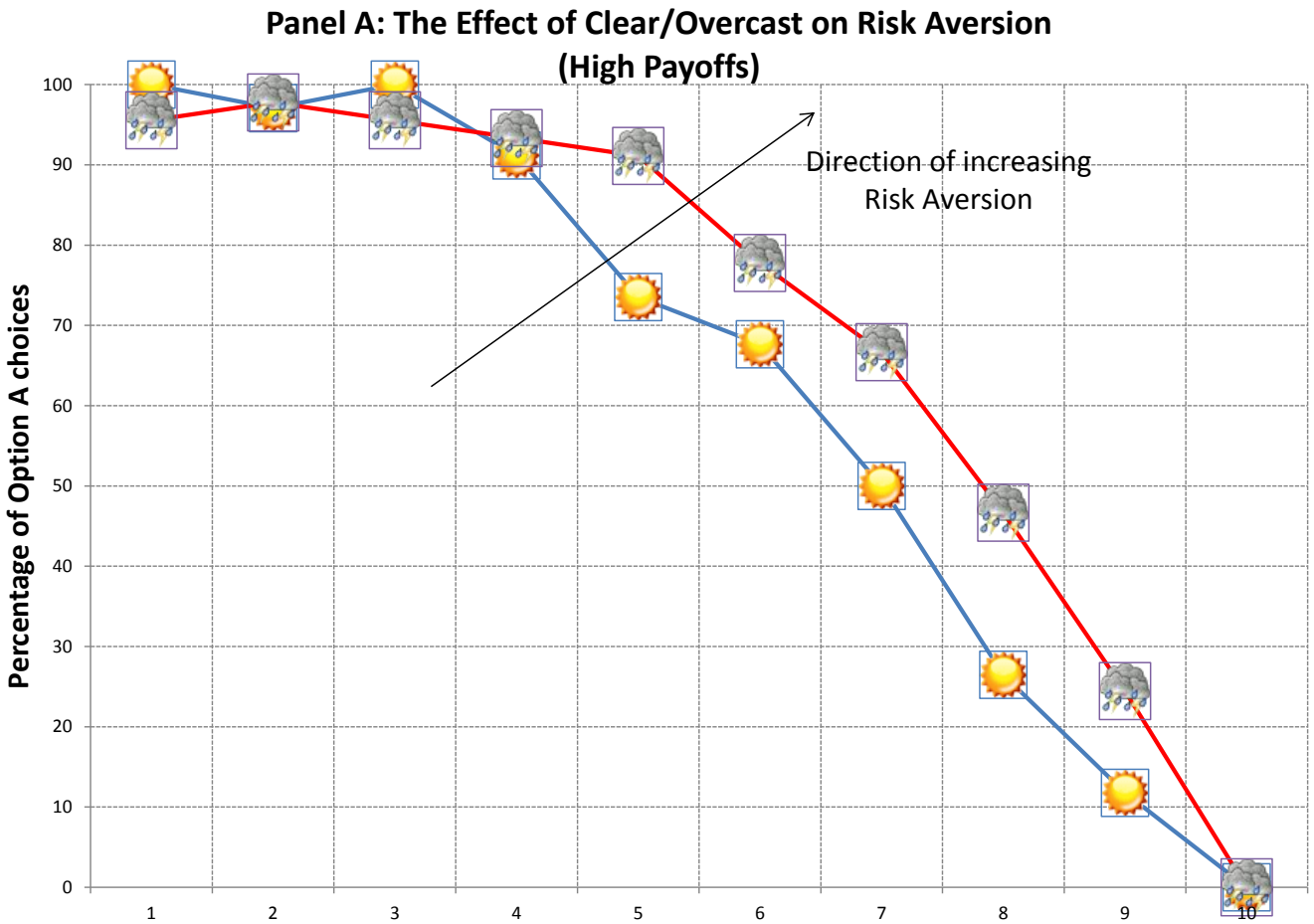

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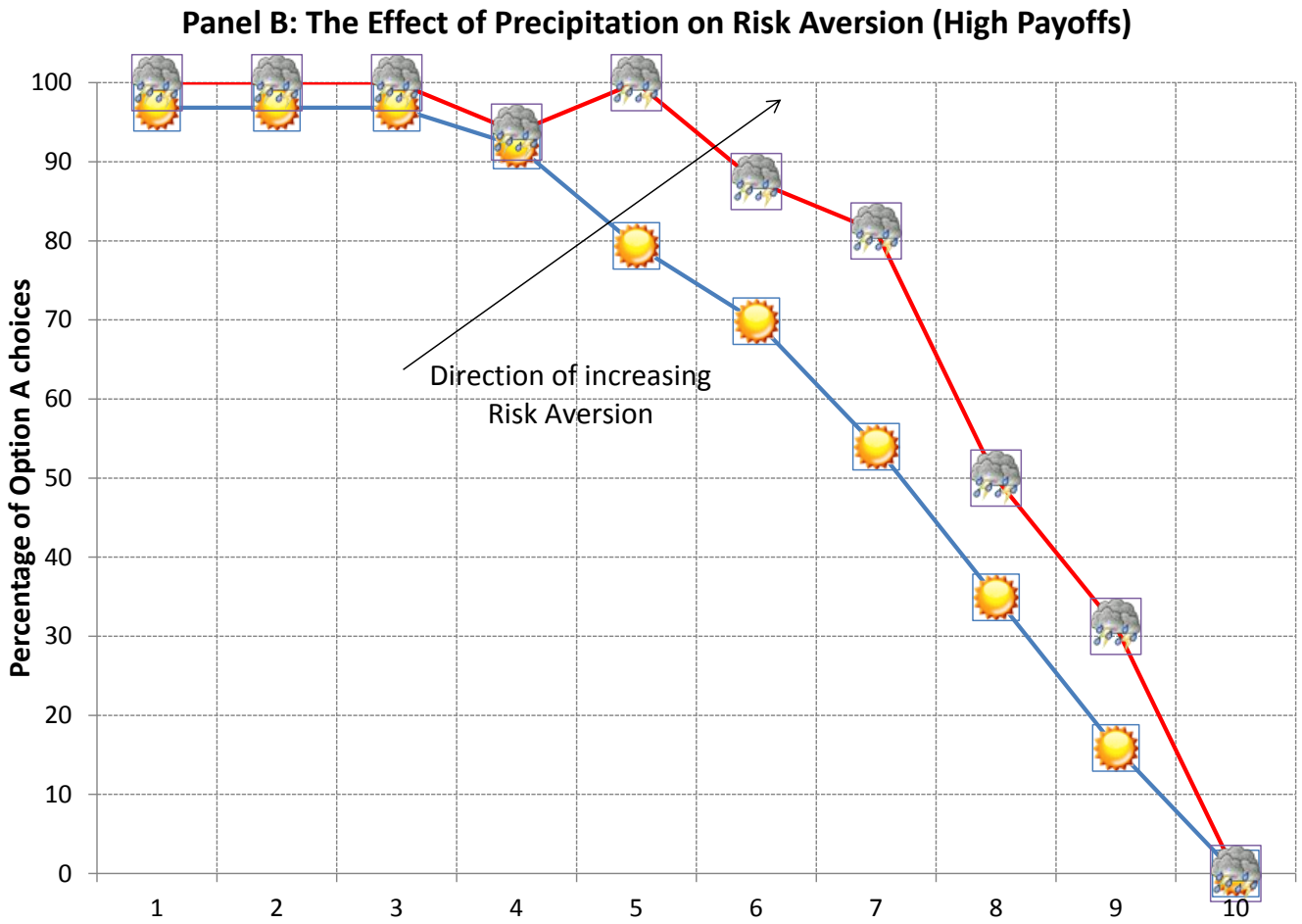

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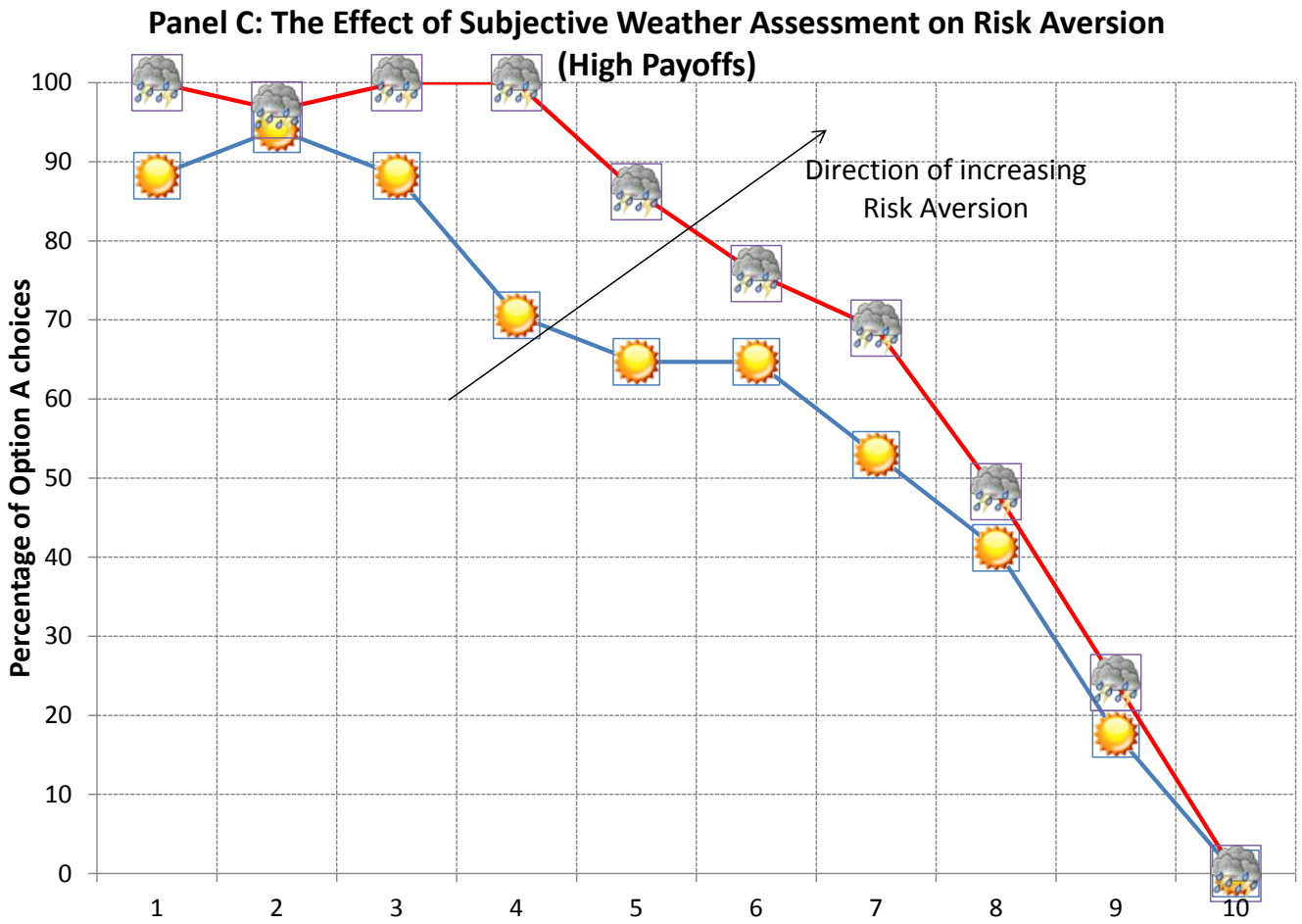

Hypothesis testing: Are these differences statistically significant?

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	Clear/Overcast	**Precipitation**	**Subjective Weather**
Bad Weather	0.705	0.756	0.700
Good Weather	0.629	0.650	0.619
$[p-values]$	[0.014]	[0.003]	[0.041]

Logit - High Payoffs

	One variable at a time	Precipitation + controls	Overcast-Clear + controls	Subjective Weather + controls
Precipitation	0.063***	0.063***		
Overcast-Clear	0.053***		0.051***	
Subjective Weather (Bad-Good)	0.037**			0.037**
Income	0.000*	0.000	0.000	0.001*
Religious (Yes-No)	0.010	0.000	0.011	0.008
Political Leaning (Liberal-Conservative)	0.012	0.000	−0.003	−0.001
Gender (Male-Female)	0.031			
Race				
White/Caucasian	−0.017			
Asian	−0.098**			
Play lotteries (Yes-No)	0.000			
Economy concerned (No-Yes)	−0.034**			

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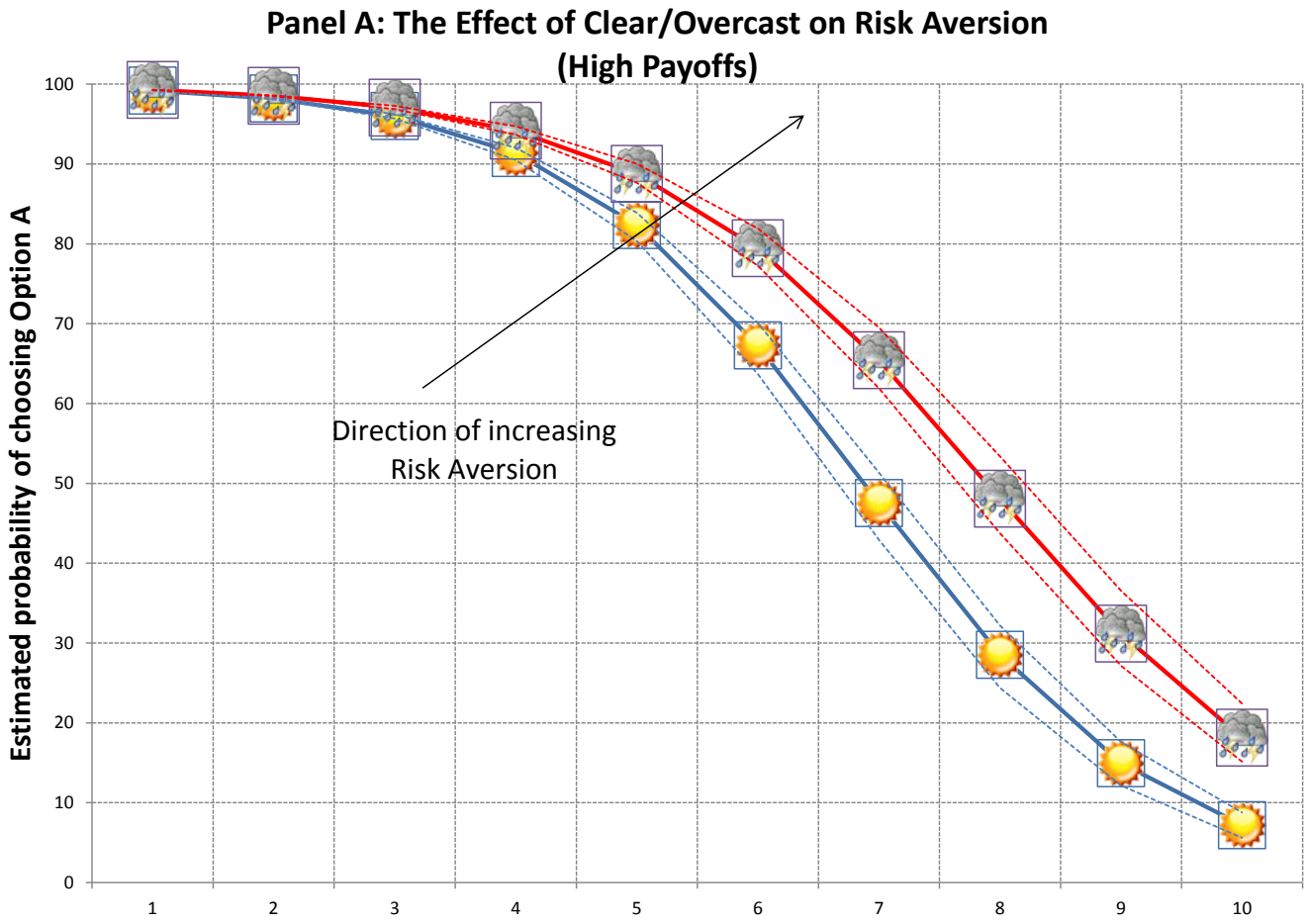

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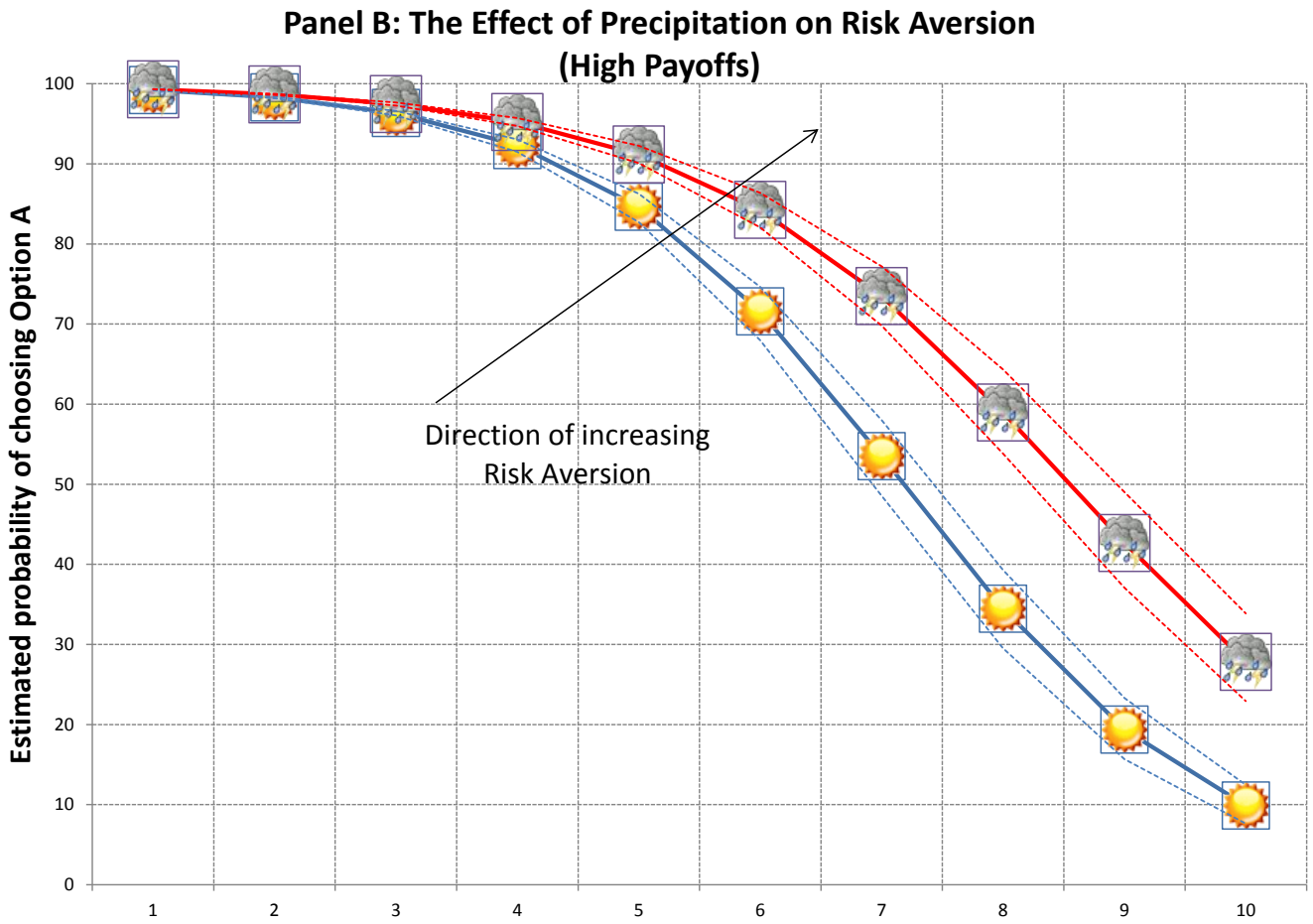

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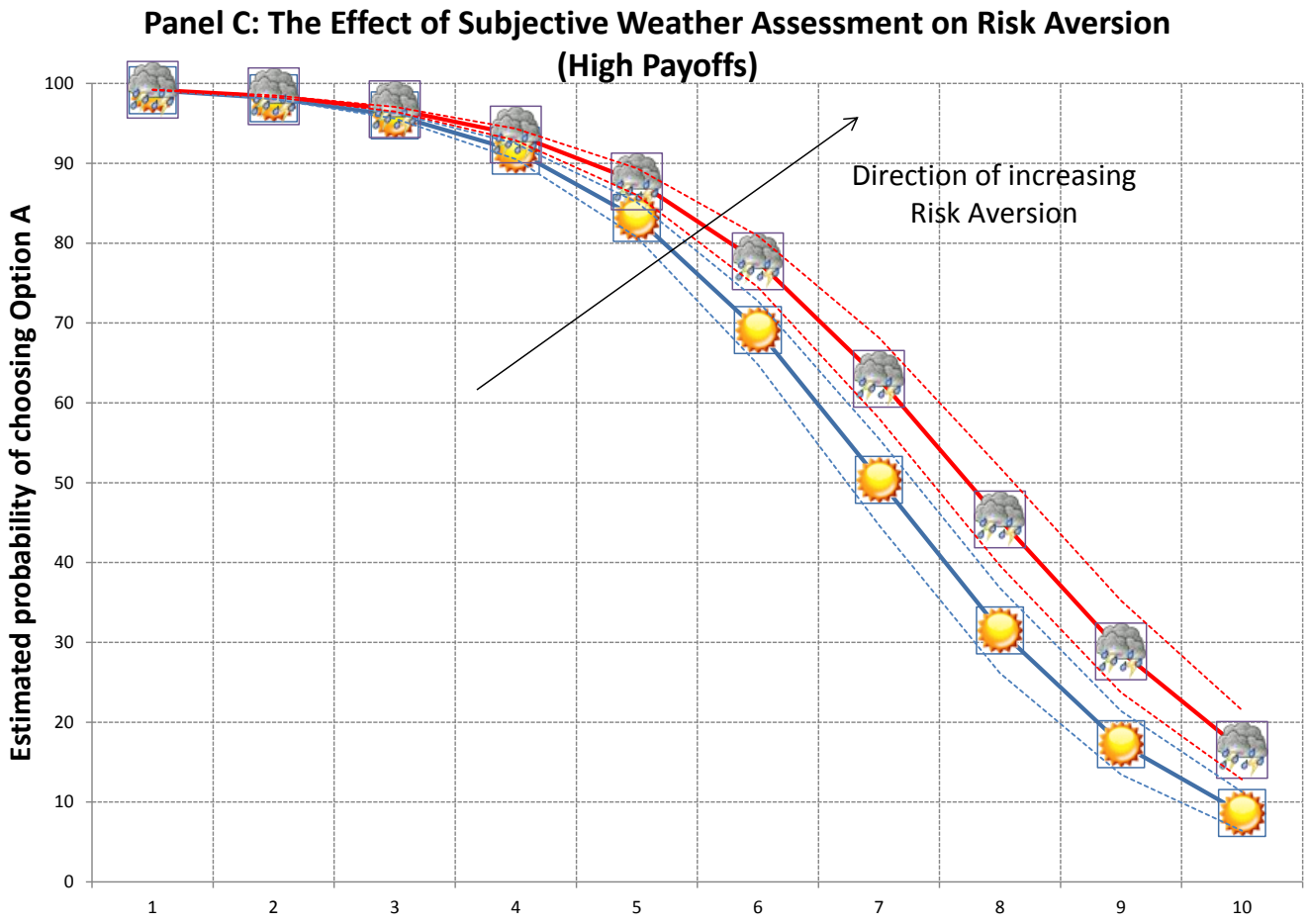

Relative Risk Aversion

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  - constant relative risk aversion ($\alpha \to 0$)
  - constant absolute risk aversion ($r \to 0$)
- Arrow-Pratt Relative risk aversion

$$\frac{-U''(x) \cdot x}{U'(x)} = r + \alpha(1-r)x^{1-r}.$$

Relative Risk Aversion Estimation

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- To better fit the smooth probability profiles, we adopt a probabilistic choice rule where μ is a noise parameter:

$$Prob(chooseA) = \frac{U_A^{1/\mu}}{U_A^{1/\mu} + U_B^{1/\mu}}$$

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$$Prob(chooseA) = \frac{U_A^{1/\mu}}{U_A^{1/\mu} + U_B^{1/\mu}}$$

- Maximum likelihood estimation for α, r, and μ

Relative Risk Aversion Estimate

	All	Subjective Weather		Precipitation		Clear-Overcast	
		Good	Bad	Good	Bad	Good	Bad
r	0.372	0.305	0.355	0.309	0.511	0.295	0.402
	[0.001]	[0.003]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α	0.146	0.106	0.172	0.109	0.330	0.084	0.200
	[0.001]	[0.001]	[0.001]	[0.000]	[0.002]	[0.000]	[0.001]
μ	0.132	0.212	0.112	0.145	0.078	0.156	0.115
	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
RRA	0.532	0.441	0.551	0.448	0.760	0.406	0.605
(Low Payoffs)			25.1%		69.6%		49.0%
RRA	1.051	0.979	1.223	0.990	1.280	0.860	1.207
(High Payoffs)	97.5%†		24.9%		29.2%		40.3%

Skewness

- Paired lotteries have same variance (and Kurtosis);
- Expected value for skewness reduction compensation.

Skewness MPL

	Option A	Option B
Decision 1 :	\$1.00 w.p 10% , \$3.00 w.p 90%	\$0.20 w.p 90% , \$2.20 w.p 10%
Decision 2 :	\$1.00 w.p 20% , \$3.00 w.p 80%	\$0.20 w.p 80% , \$2.20 w.p 20%
Decision 3 :	\$1.00 w.p 30% , \$3.00 w.p 70%	\$0.20 w.p 70% , \$2.20 w.p 30%
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Decision 10 :	\$1.00 w.p 100% , \$3.00 w.p 0%	\$0.20 w.p 0% , \$2.20 w.p 100%

Skewness moments

	Option A				Option B			
	Exp	Var	Skew	Kurt	Exp	Var	Skew	Kurt
Decision 1 :	2.80	0.36	-2.67	8.11	0.40	0.36	2.67	8.11
Decision 2 :	2.60	0.64	-1.50	3.25	0.60	0.64	1.50	3.25
Decision 3 :	2.40	0.84	-0.87	1.76	0.80	0.84	0.87	1.76
Decision 4 :	2.20	0.96	-0.41	1.17	1.00	0.96	0.41	1.17
Decision 5 :	2.00	1.00	0.00	1.00	1.20	1.00	0.00	1.00
Decision 6 :	1.80	0.96	0.41	1.17	1.40	0.96	-0.41	1.17
Decision 7 :	1.60	0.84	0.87	1.76	1.60	0.84	-0.87	1.76
Decision 8 :	1.40	0.64	1.50	3.25	1.80	0.64	-1.50	3.25
Decision 9 :	1.20	0.36	2.67	8.11	2.00	0.36	-2.67	8.11
Decision 10 :	1.00	0.00	-	-	2.20	0.00	-	-

Skewness Aversion - Low payoffs

Panel A: Low Payoffs

	One variable at a time	Precipitation + controls	Overcast-Clear + controls	Subjective Weather + controls
Precipitation	0.042^{**}	0.042^{**}		
Overcast-Clear	0.020		0.027^{*}	
Subjective Weather (Bad-Good)	0.023			0.032^{**}
Income	0.003^{***}	0.000	0.004^{***}	0.004^{***}
Religious	0.026	0.000	0.034	0.033
Political Leaning	-0.023	0.000	-0.018	-0.019

Skewness Aversion - High payoffs

Panel B: High Payoffs				
	One variable at a time	**Precipitation + controls**	**Overcast-Clear + controls**	**Subjective Weather + controls**
Precipitation	0.051***	0.051***		
Overcast-Clear	0.025*		0.031**	
Subjective Weather (Bad-Good)	0.034**			0.040**
Income	0.001**	0.000	0.001**	0.001***
Religious	0.051*	0.000	0.081***	0.081***
Political Leaning	0.027	0.000	0.058**	0.057**

Concluding Remarks

- Bad weather $\Rightarrow$ more risk aversion;

Concluding Remarks

- Bad weather $\Rightarrow$ more risk aversion;
- Good weather $\Rightarrow$ more risk seeking;

Concluding Remarks

- Bad weather $\Rightarrow$ more risk aversion;
- Good weather $\Rightarrow$ more risk seeking;
- Risk attitudes vary dramatically at high frequencies;

Concluding Remarks

- Bad weather $\Rightarrow$ more risk aversion;
- Good weather $\Rightarrow$ more risk seeking;
- Risk attitudes vary dramatically at high frequencies;
- Economic and financial consequences (consumption decisions, investments decisions, etc)!!!