UNIVERSITY of TASMANIA

Risk Preferences and the Reliability of Electricity Networks

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Motivation:

Since the inception of the Renewable Energy Target households have continued to pay more to fund a reliable network that is transitioning towards been a greener network.

Issues have been identified with intermittent generation and international energy prices limiting any perceived merit-order effects.

In this presentation we analyse whether households would accept a less-green, reliable network in exchange for lower cost increases.

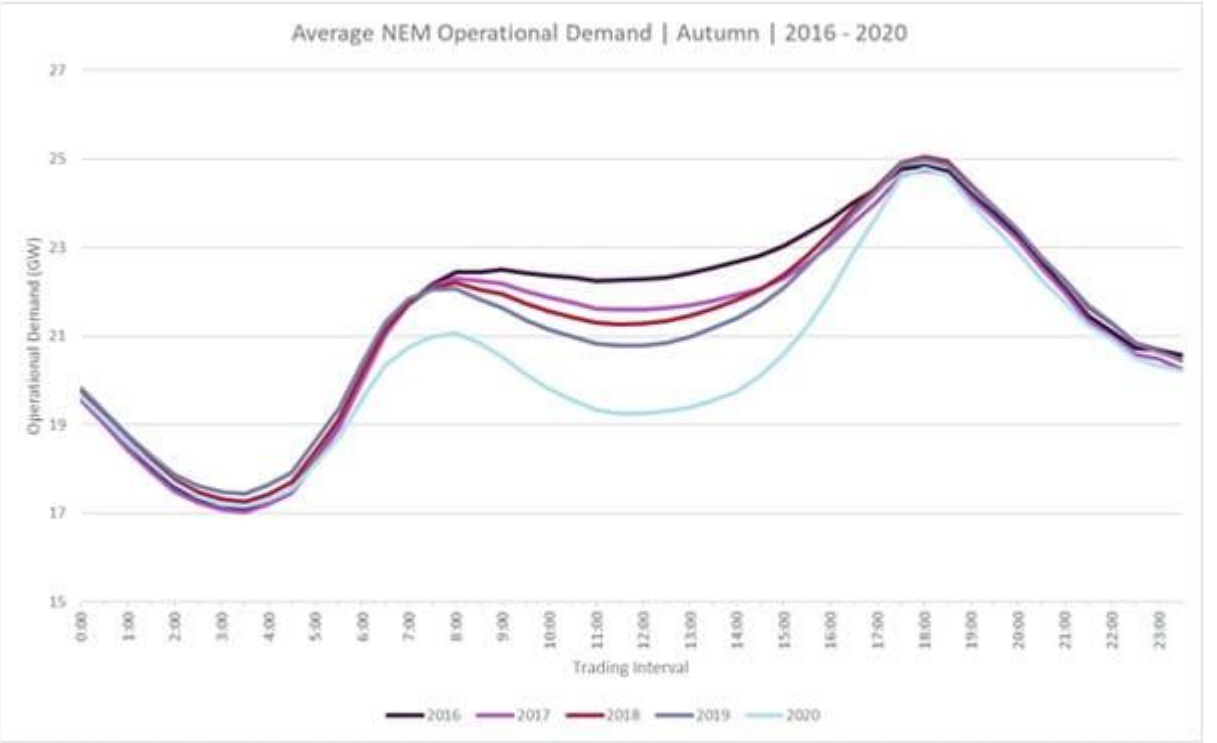
These results could be evaluated against the cost savings on delayed investment.

We also estimate the compensation required to address issues with peak consumption in the evening (Demand-Side Management)

Finally, we estimate whether a respondent's risk preference influences the amount of compensation required.

Background:

- 24% of electricity generation is now sourced from renewable technologies
- Battery Storage has started to emerge as a more commercially viable technology
- Households have funded this transition through their purchase of electricity
- Emerging Issues:
  - Merit order effects have appeared to be transitory
  - Large reductions in supply (Coal-fired generation)
  - Exposure to international prices (Gas)
  - Growing intermittency issues



Operational demand for the NEM between 2015 and 2020. This shows a reflection of the downward trend in demand over a whole season.

Source: AEMO (2022)

Research Questions

- The objective of this study is to estimate the reduction in the rate of cost increases required by households in exchange for reductions in energy investment as well as for the imposition of demand-side management policies such as consumption restrictions
  - Do households require compensation for reduction in infrastructure?
  - Do households required compensation for the imposition of demand-side management policies?
- Secondary Objective:
  - Does a respondents risk preference impact the amount of compensation required?

Literature Review: Risk Aversion

- Willingness to avoid potentially worse situations has been linked to risk preferences:
  - Insurance markets, Job Security, and Household Purchases (Guiso and Paiella, 2004)
  - Mortality risks associated with fossil fuels (Itaoka et al. 2006)
- Preferences for risk are domain-specific:
  - Premiums are willing to be paid to avoid outages (Carlsson and Martinsson, 2007; Abdullah and Mariel, 2010; Hensher et al., 2014).
  - Respondents who believe the risk of climate change to be higher are willing to pay a premium to mitigate these risks
  - Part of the social cost of carbon may be positively associated with how risk-averse society is (Antoff et al. 2009)
- Part of the novelty of our study is in the estimation of the difference in compensation required for those respondents who are highly risk-averse

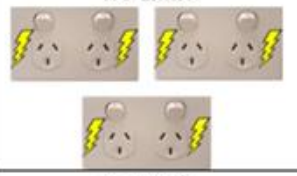
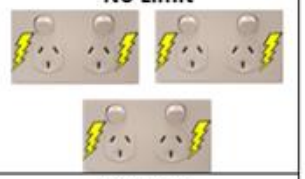
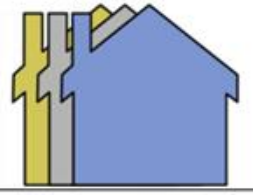
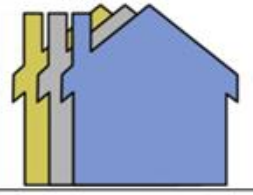
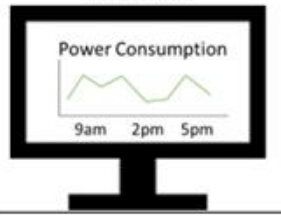
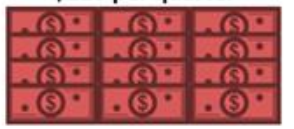
Survey Methods:

- Survey included a multiple-treatment DCE sampled across Victoria and New South Wales run in June 2019 [UTAS Ethics Clearance H0016832]
- The treatment presented today included 302 respondents completing six choice tasks each as well as a risk preference elicitation exercise
- In the DCE the status quo was traded off against cheaper alternatives with lower levels

Attributes:	Levels:
Proportion of Generation from Renewable Sources	15%, 30%, 45%, 60%
Consumption Restrictions	Two Restrictions, One Restriction, No Restrictions
Consumption Information	Quarterly, Daily Reminders, Real-Time Reminders
Community Storage	0 MWh, 20 MWh, 40 MWh, 60MWh
Fixed cost increase per quarterly for 5 years to your household	$0, $10, $20, $30, $40, $50, $60, $70, $80, $90, $100, $110
Status Quo Contract Levels:	60%, No Restrictions, Real-Time Reminders, 60MWh, $120

Description of Attributes:

- Infrastructure Attributes:
  - Proportion of Renewables (60% based on technical literature)
  - Community Storage (Batteries varying in size to reduce outages)
- Demand-Side Management Attributes:
  - Consumption Information Frequency (Daily and Real-Time)
  - Consumption Restrictions
    - Use of technology to limit appliance use during peak period
    - Appliances grouped by activity:
      - Entertainment (Television, computers, Stereo)
      - Cooking (Microwave, ovens, kettle)
      - Cleaning (Washing Machine, Dishwasher)
- Cost (Payment Vehicle) Fixed payment aligned with two-part tariffs

Features	Option A No change	Option B	Option C
% of Renewable Generation	60% 	30% 	45% 
Consumption Limits	No Limit 	Low Limit 	No Limit 
Community Storage	60 MWh 	60 MWh 	20 MWh 
Consumption Information	Real-Time 	Quarterly 	Daily 
Average bill increase per quarter over the next five years	$120 per quarter 	$40 per quarter 	$20 per quarter 

Experimental Design:

- A Bayesian efficient design was employed for this study:
  - Initially priors were identified from the literature for renewables and cost
  - Utility Balance and expected sign employed for remaining priors
  - Multinomial Logit model estimated with pilot data (N = 80)
  - Updated design utilised statistically significant estimates
  - Simulated Bayesian D-efficient error of 0.002851
- Design was generated in Ngene
  - It was not possible to select a zero-cost contract without at least one consumption restriction

Econometric Model:

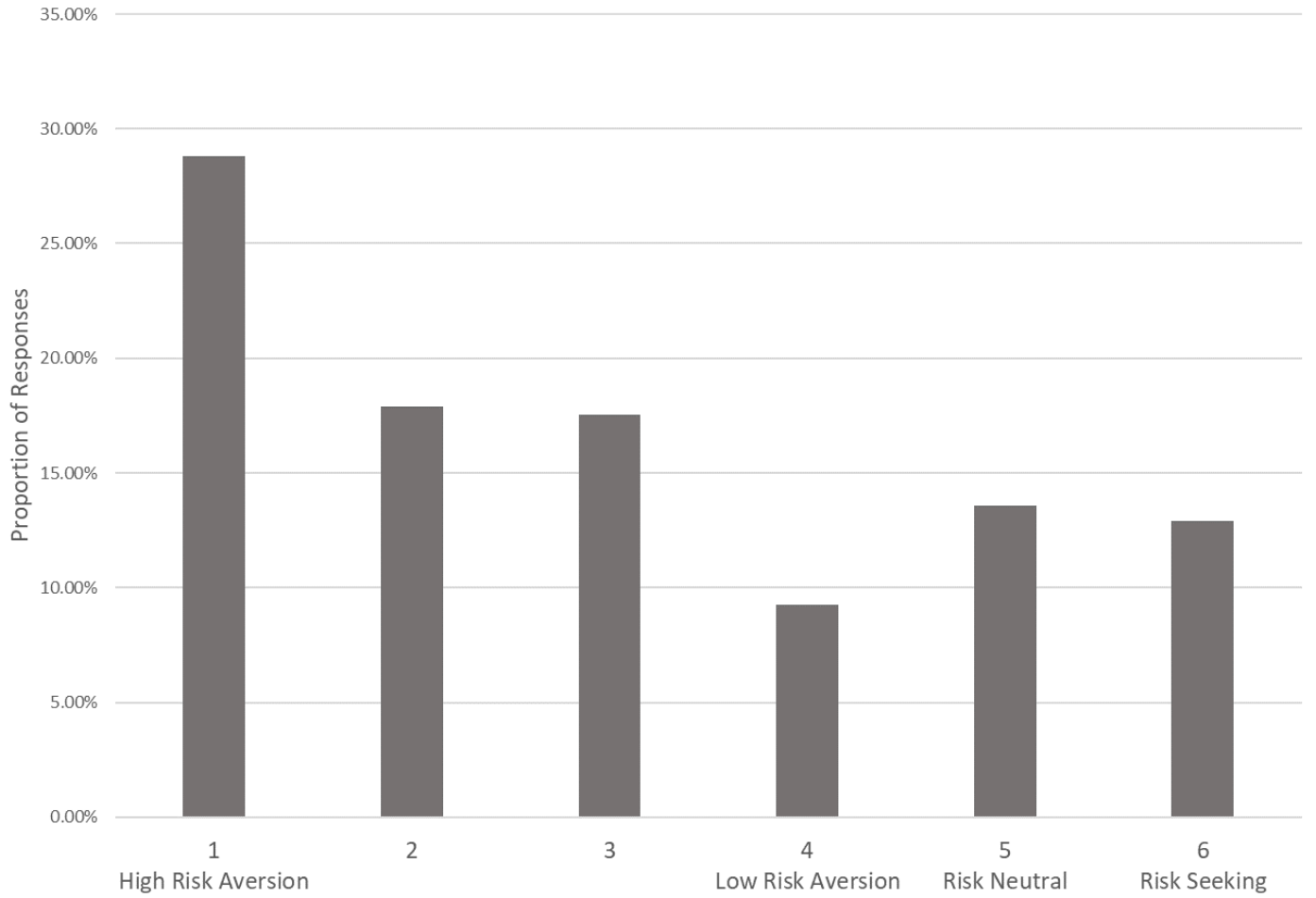
- $U_{njc} = -\beta_c p_{njc} + \omega x_{njc} + \partial_{njc} + \varepsilon_{njc}$
  - Estimated in willingness to pay space (Train and Weeks, 2005)
- Final model was a mixed logit that included random parameters and an error component
- Random Parameters $\beta_{nk} = \beta_k^m + \beta_k^i s_n + \gamma \tau_{nk}$
  - Research questions focuses on estimation of β_k^i
  - Full correlation is estimated
  - Normal distribution for all attributes except cost which is lognormal

Risk Preference Elicitation Exercise:

- Based on the Eckel and Grossman (2002) lottery
  - Select from six option with varying expected values
  - Option A (Significantly Risk-Averse) to Option F (Risk Seeking)

	Result	Payoff	Chance
Investment F1	X	28	50%
	Y	28	50%
Investment A6	X	2	50%
	Y	70	50%
Investment E2	X	24	50%
	Y	36	50%
Investment C4	X	16	50%
	Y	52	50%
Investment B5	X	12	50%
	Y	60	50%
Investment D3	X	20	50%
	Y	44	50%

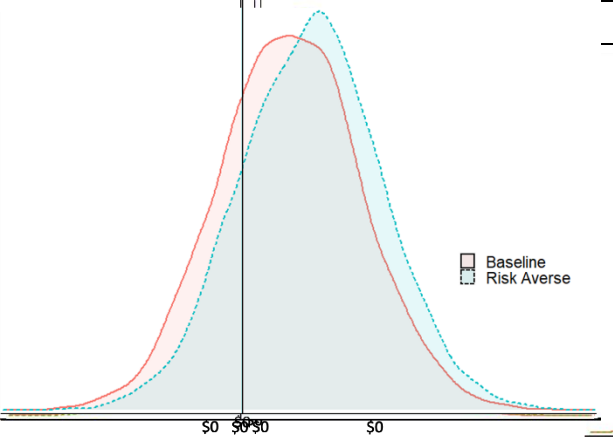
Results: Distribution of Risk Preferences

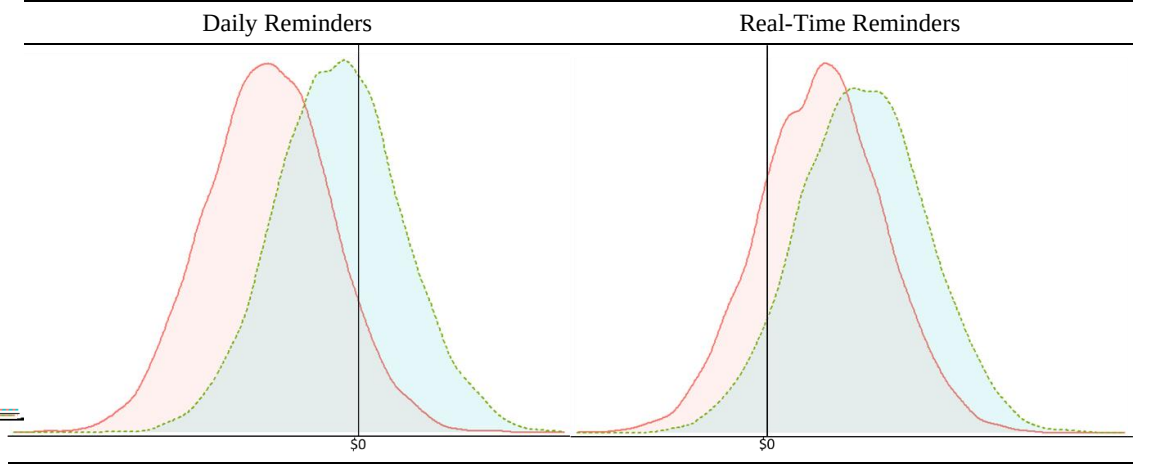


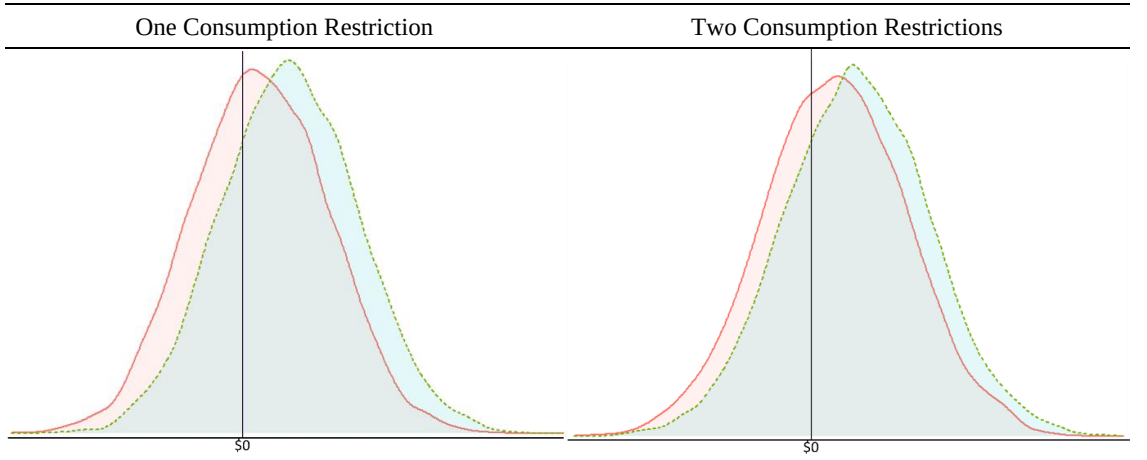
Results: Mixed Logit Model

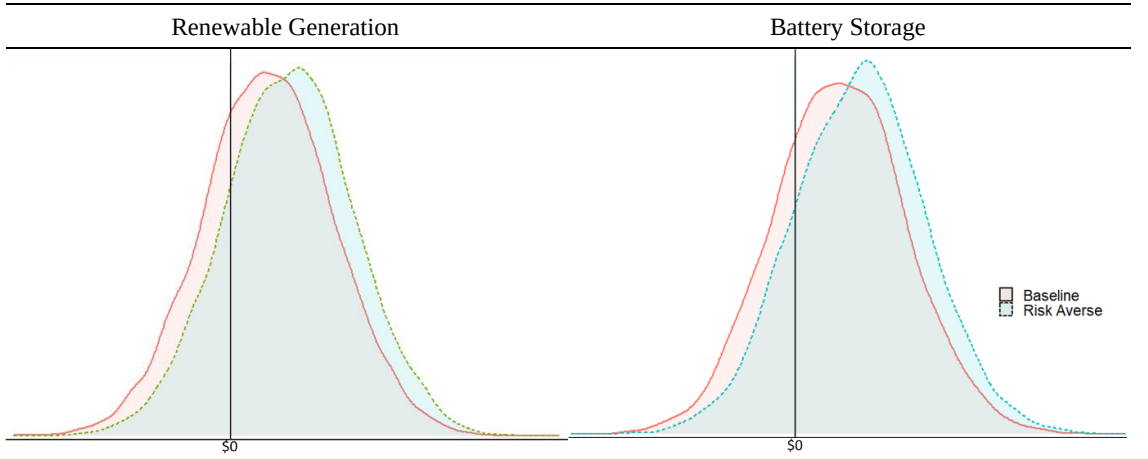
Attributes	Parameter (Robust Standard Error)		
	Mean	Interactions	Standard Deviation
Daily Reminders	-5.841*** (0.374)	6.100*** (0.281)	11.840*** (0.107)
Real-Time Reminders	5.235*** (0.318)	3.071*** (0.265)	7.926*** (0.126)
One Consumption Restriction	0.891*** (0.247)	9.954*** (0.318)	19.867*** (0.277)
No Consumption Restrictions	15.571*** (0.255)	11.394*** (0.306)	33.244*** (0.267)
Renewable Generation	0.682*** (0.011)	0.038*** (0.013)	1.026*** (0.006)
Storage	0.242*** (0.007)	0.076*** (0.008)	0.504*** (0.004)
Household Cost ($/year)	-3.185*** (0.212)	1.018*** (0.349)	2.643*** (0.344)
ASC (Status Quo)	-128.912*** (2.005)		
ASC (Option C)	-7.657*** (0.225)		
Error Component			-145.377*** (1.321)
Diagnostics			
No. of Observations			2,416
Log-Likelihood			-1,789.654
AIC			3,669.308
BIC			3,836.277
McFadden Pseudo R^2			0.326

*** 1% significance ** 5% significance * 10% significance.


Baseline
Risk Averse
$0
$0
$0
$0


Daily Reminders
Real-Time Reminders
$0
$0


One Consumption Restriction
Two Consumption Restrictions
$0
$0


Renewable Generation
Battery Storage
$0
$0
Baseline
Risk Averse

Discussion:

- Risk Aversion may be a factor in respondents requiring more compensation
- Potential Explanations:
  - Reminders – Less ability to monitor consumption/expenditure
  - Storage – Less reliable network, increased risk of outages
  - Renewables – Climate change risk
  - Consumption Restrictions
- Policy Relevance:
  - Comparison costs of compensation versus benefits resulting from delayed investment
  - Consumption restrictions may be especially relevant as a short-term mitigation of the risks associated with peak demand

Limitations and Next Steps:

- Three treatments would be ideal:
  - Discrete Choice only
  - Discrete Choice then Risk Preference
  - Risk Preference then Discrete Choice
- Significant heterogeneity still exists
- Why do risk averse people require more compensation?
  - What is the source of risk?
- Renters were excluded

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Thank You for listening