Preference for indoor ambient heating with explicit interpersonal influence

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Context

- NZ Government spent \$350m to subsidize retro-fitting of clean heating and insulation
- unclear what values the affected population place on improved heating
  - RCTs give the improved devices away for free
  - RCT projects asked participants how much they would pay, and reported values of one-fifth to one-half capital cost
- We use choice experiments to provide evidence on the willingness to pay (WTP) for clean heating and humidity control devices
  - Derived for a group that suffers from a high burden of respiratory disorders, has poor housing and mostly rent rather than own

Population Studied

Pacific Island immigrants in Auckland and Hamilton

- Largest and 3rd largest cities in NZ in terms of Pacific populations
  - Damp, humid and temperate climate
    - $\approx$ inches per year rainfall, relative humidity of 85%
    - Mean annual temp 15°C (Auckland), 14°C (Hamilton)
    - July mean 10.9°C (Auckland), 8.9°C (Hamilton)
    - c.f. Pacific Islands mean 23°C, July mean of 21°C
  - High proportion of housing stock constructed during leaky homes' period due to rapid population growth
  - Pacific Islands group reports lowest housing satisfaction
    - 33% find their house too cold vs 15% overall

Sample Characteristics

- $N = 249$, mostly Tongan plus assorted Melanesians
  - 43% males Survey included focus groups, split into male, female and youth (18-25), with age/ethnic specific survey team leaders
  - 47% high school quals, 22% no quals, 31% some tertiary (including trades)
  - 51% E/P rate (same as overall PI in HLFS, March 2013)
  - Mean income of $21,500 (overall PI is $24,900 which is one-third below national average)
- 82% renting (Tongans had 2^{nd} lowest home ownership rate of any ethnic group in 2006 Census)
  - Even lower here because many are recent migrants
  - Average rent of $311 per week (2013)
  - Hypothetical rent for owner-occupiers of $377/week

Housing Characteristics

- Important to capture these because choice experiment design pivots on current rental costs and dwelling characteristics
- $\longrightarrow$ Capture several housing attributes

Dwellings are crowded

- 8 residents per dwelling, 2.4 per proper bedroom
- garages and lounges often used for sleeping
- No difference between renters and owners

- High dissatisfaction with current housing
  - 73% have visible mould in one or more rooms
  - 61% find dwelling too cold
  - 78% find dwelling too difficult or costly to heat

Choice experiment design

Choices over various combinations of six improved heating/humidity control devices

% whose dwelling has this device

	Renters	Owners
Heat pump	7.8	4.5
Electric heater	56.1	38.6
Gas bottle heater (unflued)	6.3	0
In-built gas heater (flued)	24.4	22.7
Open fireplace	28.3	22.7
Enclosed wood burner	1.5	29.5
Dehumidifier	4.9	9.1
HRV (heat-recovery ventilation	3.4	2.3

< 10% have improved devices that warm or dry the air (heat pumps, HRV, dehumidifiers)

Choices over various combinations of six improved heating/humidity control devices and variation in rent, for a dwelling like current one

Choice experiments with interactions - preliminary results

Methodological Steps

- general research area: content validity of stated preference methods for nonmarket valuation
- specific question: is the effect of influencial advice detectable in preference structure?
  1) first choice experiment to elicit preferences
  2) group interaction and elicitation of interpersonal influence rating (self-reported)
  3) second choice experiment (identical)
  4) CE1 data analysis to derive utility structures of respondents (mixed logit)
  5) CE2 data analysis to investigate effects of influencial subjects (mixed logit)
  6) joint estimation of CE1 and CE2 responses inclusive of effects (biv. probit panel rand. effects)

Utility function

- Let j be the alternative, β_{kn} the utility weight for respondent n and related to attribute x_k
- The utility function is assumed to be linear in the parameters, specifically

$$V_n = \begin{array}{l} \beta_{1n}HRV + \beta_{2n}WDBRN + \beta_3 ELHEAT + \\ \beta_4 GSHEAT + \beta_5 HTPMP + \beta_{6n}DEHUM + \\ \beta_7 RNT + \beta_{8n}LFTALT \end{array} \tag{1}$$

- The binary probability of heating system selection is logit:

$$\Pr(j) = [1 + \exp(\Delta V_n)]^{-1} \tag{2}$$

- Conditional on the estimates on the first set of choice experiments, using ex-post individual-specific coefficient estimates $\hat{\beta}_n$, the predicted differences for the utilities of the alternatives in the second experiments are derived for all respondents, denoted by $\Delta\hat{v}_n$

Utility function

- to test the effect of subjects who emerged as influential in the group discussion that preceeded the second CE, the second estimation included for each subject the $\Delta\hat{V}_n^*$ of the individual rated as most influential by the subject. The utility difference was:

$$\begin{aligned}\Delta V_n = \quad & \beta_{1n} HRV + \beta_{2n} WDBRN + \beta_3 ELHEAT + \\ & \beta_4 GSHEAT + \beta_5 HTPMP + \beta_{6n} DEHUM + \\ & \beta_7 RNT + \beta_{8n} LFTASC + \beta_9 \Delta\hat{V}_n^*\end{aligned} \tag{3}$$

- Several panel models were estimated, but three preliminary models are reported:
  1) M1, all coefficients fixed, except β_9 for $\Delta\hat{V}_n^*$ ($\ln \mathcal{L}^* = -1151.82$ up from $\ln \mathcal{L}^* = -1211.1$ of the FC logit)
  2) M2, coeff for $HRV, WDBRN, DEHUM, LFTASC$ random ($\ln \mathcal{L}^* = -1150.78$, improving by)
  3) M3, coeff for $HRV, WDBRN, DEHUM, LFTASC$ & $\Delta\hat{V}_n^*$ random ($\ln \mathcal{L}^* = -1143.32$)

Model from choice experiment 1, used to derive $\Delta\hat{V}_n^*$

Integration points = 7 Wald chi2(7) = 328.41
Log likelihood = -1207.9902 Prob > chi2 = 0.0000

y1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
HRV	1.188651	.1001005	11.87	0.000	.9924575	1.384844
WDBRN	.2878129	.078457	3.67	0.000	.1340401	.4415857
EL_HEAT	.165717	.0829755	2.00	0.046	.0030881	.3283459
GS_HEAT	-.1254903	.0705511	-1.78	0.075	-.263768	.0127874
HT_PMP	.4059491	.0831338	4.88	0.000	.2430099	.5688884
DEHUM	.2107795	.0769324	2.74	0.006	.0599949	.3615642
RNT	-.1381863	.0082072	-16.84	0.000	-.154272	-.1221006
_cons	.213063	.055941	3.81	0.000	.1034206	.3227054

Random-effects Parameters	Estimate	Std. Err.	[95% Conf.	Interval]
ric_id: Independent				
sd(HRV)	.5736472	.1522585	.3409709	.9651001
sd(WDBRN)	.257951	.3598055	.0167583	3.97049
sd(DEHUM)	.1615956	.4316731	.0008602	30.35703
sd(_cons)	.2526475	.1683849	.0684235	.9328783

LR test vs. logistic model: chi2(4) = 6.20 Prob > chi2 = 0.1847

M3 from choice experiment 2, used to test the effect of $\Delta \hat{V}_n^*$ on respondents (does the opinion of influencial subjects in the group matter?)

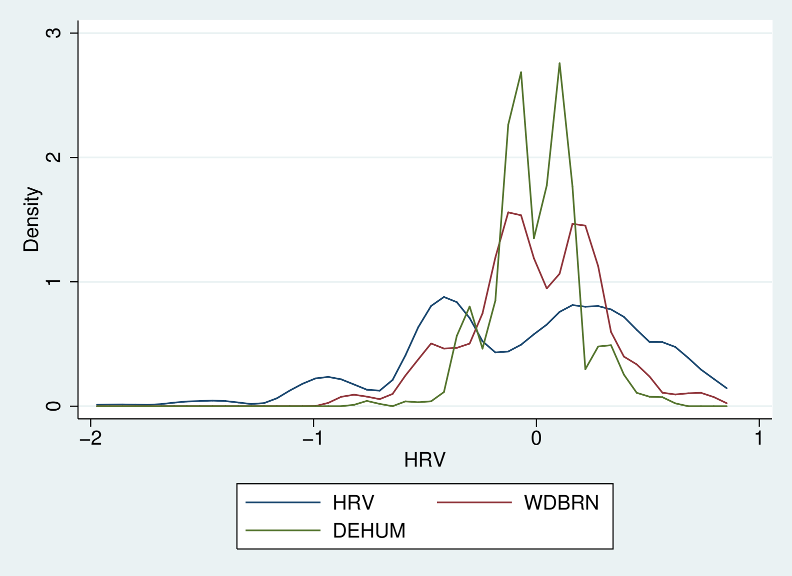
Log likelihood = -1143.3178 Prob > chi2 = 0.0000

y2	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
HRV	1.836619	.1517473	12.10	0.000	1.539199	2.134038
WDBRN	.5479028	.1064417	5.15	0.000	.339281	.7565246
EL_HEAT	.275418	.0979282	2.81	0.005	.0834823	.4673538
GS_HEAT	-.1616177	.0829161	-1.95	0.051	-.3241302	.0008948
HT_PMP	.4948139	.1034528	4.78	0.000	.2920501	.6975778
DEHUM	.2501789	.096971	2.58	0.010	.0601192	.4402386
RNT	-.1515577	.0101657	-14.91	0.000	-.1714821	-.1316332
dv_max	-.0850759	.063111	-1.35	0.178	-.2087711	.0386193
_cons	.3223119	.0738496	4.36	0.000	.1775694	.4670544

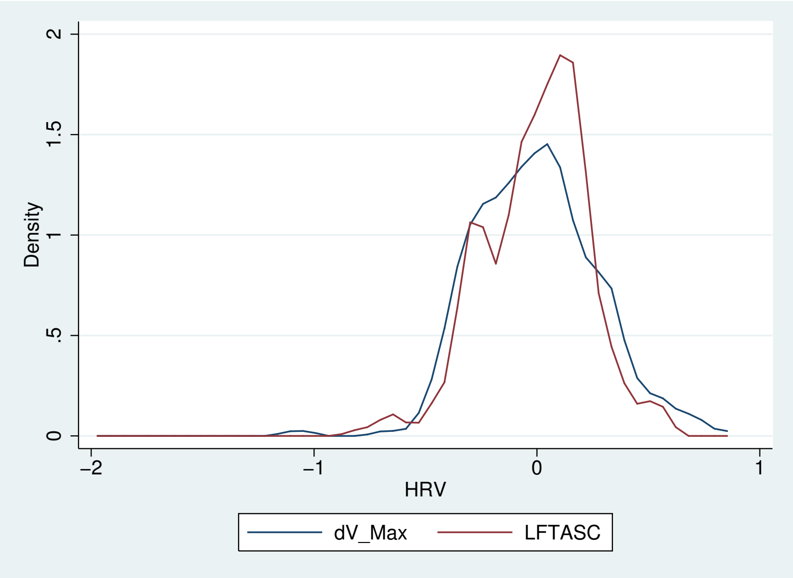
Random-effects Parameters	Estimate	Std. Err.	[95% Conf.	Interval]
ric_id: Independent				
sd(HRV)	.9543458	.1773332	.6630381	1.37364
sd(WDBRN)	.6995695	.2155482	.3824392	1.279674
sd(DEHUM)	.5300303	.2060729	.2473763	1.135647
sd(dv_max)	.5477547	.0976695	.3861975	.776896
sd(_cons)	.507882	.125234	.3132368	.8234796

LR test vs. logistic model: chi2(5) = 38.28 Prob > chi2 = 0.0000

Individual-specific $\hat{\beta}_n$ for heating attributes from M3



Individual-specific $\hat{\beta}_n$ for $\Delta\hat{V}_n^*$ and $LFTASC$ from M3



Panel random effect bivariate probit, structural parameters of y_1 and y_2

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Mixed-process multilevel regression             Number of obs     =      2,241
                                                Wald chi2(15)     =     474.58
Log pseudolikelihood = -2178.0665               Prob > chi2       =     0.0000
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	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
y1						
HRV	.6541297	.0472722	13.84	0.000	.5614779	.7467815
WDBRN	.1497143	.045076	3.32	0.001	.0613669	.2380618
EL_HEAT	.0694203	.0482305	1.44	0.150	-.0251097	.1639503
GS_HEAT	-.0749377	.0426179	-1.76	0.079	-.1584673	.0085919
HT_PMP	.2222403	.0466972	4.76	0.000	.1307155	.3137651
DEHUM	.1237378	.0444535	2.78	0.005	.0366105	.2108651
RNT	-.0781916	.0047331	-16.52	0.000	-.0874683	-.0689149
_cons	.1153765	.031666	3.64	0.000	.0533123	.1774406
y2						
HRV	.83365	.0606295	13.75	0.000	.7148184	.9524816
WDBRN	.2403346	.0545092	4.41	0.000	.1334985	.3471707
EL_HEAT	.0892143	.0586154	1.52	0.128	-.0256697	.2040983
GS_HEAT	-.079254	.0496309	-1.60	0.110	-.1765288	.0180207
HT_PMP	.2129174	.0555464	3.83	0.000	.1040485	.3217864
DEHUM	.1204776	.0536291	2.25	0.025	.0153665	.2255887
RNT	-.0750152	.0054087	-13.87	0.000	-.0856162	-.0644143
dv_max	-.046791	.0292741	-1.60	0.110	-.1041672	.0105852
_cons	.1261202	.0371882	3.39	0.001	.0532327	.1990078
/lnsig_1_1	-2.057918	.5764079	-3.57	0.000	-3.187657	-.9281796
/lnsig_1_2	-1.460889	.2237485	-6.53	0.000	-1.899428	-1.02235
/atanhrho_~12	.3979982	.5885502	0.68	0.499	-.7555389	1.551535
/atanhrho_12	.8684406	.0514067	16.89	0.000	.7676853	.969196

Panel random effect bivariate probit, cross equation covariance for y_1 and y_2

Random-effects Parameters		Estimate	Std. Err.	[95% Conf.	Interval]
Level: ric_id					
y1					
Standard deviations					
_cons		.1277196	.0736186	.0412684	.3952726
y2					
Standard deviations					
_cons		.23203	.0519164	.1496543	.3597487
Cross-eq correlation					
y1	y2				
_cons	_cons	.3782348	.5043512	-.6384418	.9140384
Level: Residuals					
Standard deviations					
y1		1	(constrained)		
y2		1	(constrained)		
Cross-eq correlation					
y1	y2	.700581	.0261756	.6455815	.7483508

Conclusions and way forward

Conclusions

- Influence of subjects has a variable effect, but it is detectable
- Utility measures (marginally) improve both separate and simultaneous preference estimation in panel data
- Preference for heating devices are mostly stable across experiments

Way forward

- Refine the influence effects separately at the attribute level (rather than at the overall utility level)
- Move to a simultaneous estimation (Structural Choice Models?) to achieve efficiency