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On the stability of preferences and attitudes: a hybrid model of air travel preferences at two different points in time

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ABSTRACT: Many methods have been developed to give transport policy makers better insight into why different choices are made. One such methodology that has been receiving increasing attention is the hybrid choice model, which seeks to allow for a better understanding of the relationship between choices and attitudes or character traits latent to the respondent. Recently there has been debate as to the appropriateness of using such models to conclude that a change in a given attitude will bring a change in choice given the focus on cross-sectional data. To address this, we propose a framework to examine the stability of choices and attitudes over time. Making use of a repeated stated preference experiment conducted at two points in time on an identical set of respondents we find that, in the context of air security procedures, preferences and latent attitudes are relatively stable over time despite the two different and extreme shocks at the times the survey was conducted. While this is comforting to transport policy makers in some respects, these results lead one to ask that if choices and preferences do not change in extreme situations how changeable are they truly in the context of a nudge agenda by many governments? Additionally, we find some evidence that for the most part while latent attitudes are invariant, the role they play in choices differs over waves suggesting potential cognitive dissonance.

KEY WORDS: ***Hybrid choice, preference stability, panel data, stated preference, attitudinal change***

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1. INTRODUCTION

1.1 Aviation and air security

The period between 2014 and 2015 was particularly bad for aviation travel with numerous high profile incidents. On 8 March 2014, Malaysian Airlines Flight 370 disappeared over the Indian Ocean and is yet to be found (with the search to be ended by the end of 2016). Shortly after, on 17 July, Malaysian Airlines Flight MH17 was shot down over Ukraine, and on 28 December, Air Asia Flight 8501 crashed into the Java sea after a malfunction and a subsequent pilot error. On 4 February 2015, we witnessed the disturbing broadcasts of TransAsia Flight 235 crashing into the Huandong Viaduct in Taipei, Taiwan, while on 24 March 2015, GermanWings Flight 9525 crashed into the French Alps due to deliberate action by the pilot. All of these were high profile events globally, but the Malaysian Airlines received significant media attention in Australia due to involvement in the search for MH370 and the fact that a number of Australians were travelling on MH17.

In December of 2014, among these air incidents, a gunman associated with a terrorist group held a number of people hostage within the Lindt Café in Martin Place, the centre of the Sydney CBD. While this was an instance of domestic terrorism, the ongoing conflict in Syria combined with persistent terror incidents globally, and speculation at the time that MH370 may have been hijacked, no doubt gave rise to concerns about international travel and the level of security and screening deployed at airports for passengers and staff alike. Indeed, while international tourism grew at 4.4% globally last year, Australia's only grew at 2 percent, indicating that all of these events may have had an impact on travel and tourism (*1*), much like the significantly lower growth the US experienced after the 9/11 attacks (*2*).

Surprisingly, there is no research in the literature that examines the role of the security process in the choice to travel and preferences surrounding different security regimes. While research has examined why people travel (see e.g. *3,4,5*), travel under different health crises and natural disasters (see e.g. *6,7,8*) as well as how terrorism affects tourism (see e.g. *8,9*), none have directly examined air travel and security therein. The most relevant study to this paper is the RAND Europe study into the perception of the public with respect to security and privacy; in particular trading personal freedoms for increases in security in rail travel (*10*). This study, which informed several aspects of the design of the experiment used in this paper, found that attitudes to privacy and personal information significantly impacted on the security preferences of respondents (*11*).

1.2. Incorporating attitudes

While it is common to collect answers to attitudinal questions during stated choice surveys (e.g. responses on Likert scales), there is now a large stream of literature that argues that such questions are not direct measures but rather indicators of underlying attitudes, and should thus not be used as explanatory variables (*12,13,14*). Instead, attitudes should be treated as latent constructs that explain the answers to these questions and at the same time influence the choice behaviour. This seeks to avoid endogeneity bias as well as deal with measurement error as the responses to the attitudinal questions are no longer treated as explanatory variables but as dependent variables. Applications of this model in a variety of transportation contexts have become widespread in recent years, examples include (*15,16,17,18,19,20*).

Despite their widespread use over the last decade, recent work by (*21*) argues that the potential to derive policy implications from these latent models is limited, citing two potential issues. Firstly, any policy designed to influence the latent construct and thus influence choice is not supported by the cross-sectional nature of data used in these studies. Indeed, answers to attitudinal questions are typically measured at one point in time meaning that only between respondent differences can be examined, and not how a respondent's own behaviour may change based on a change in the underlying latent variable (as no data for that exists). Secondly, they also state that latent variable models are also prone to endogeneity bias as the analyst cannot be sure if it is the underlying attitudes that are influencing the choices and answers to attitudinal questions, or if these answers are influenced by the choices made.

1.3. Contribution of this paper

In response to (*21*), this paper makes use of a unique dataset to provide insight on a number of fronts. We propose a hybrid choice model framework to examine the consistency of both preferences and underlying attitudes and operationalise the framework on data collected in Sydney, Australia regarding security preferences in international air travel. One wave was conducted shortly after the MH17 incident in July 2014 and the second wave in December 2014 the after the terror related hostage siege in the Sydney CBD. In each sample, there is a pool of respondents who completed the same attitudinal questions and identical choice tasks at two different points in time, five months apart. This paper represents a starting point for the exploration of the relationship between choice and attitudes overtime within the hybrid choice model framework.

2. METHODOLOGY

We specify the deterministic utility of alternative i in choice task t for respondent n in Wave A as

$$V_{intA} = (\delta_{i,A} + \beta_A x_A) \qquad (1)$$

where $\delta_{i,A}$ is a constant for alternative i, normalised to zero for one of the *J* alternatives, while β_A are estimated utility terms.

In Wave B, we use

$$V_{intB} = \mu_B(\delta_{i,B} + \beta_B x_B) \qquad (2)$$

where μ_B is an additional scale term for Wave B. The taste coefficients in Wave B are given by $\beta_B = \beta_A + \Delta_B$, allowing for shifts in sensitivities for individual coefficients, where significant. The estimation of the scale difference μ_B is possible if at least one of the Δ_B terms is set to zero.

We next specify a set of latent attitudes, with the l^{th} latent variable for respondent *n* in wave *A* being defined as:

$$\alpha_{l,n,A} = \gamma_{l,A} z_{n,A} + \xi_{l,n,A} \qquad (3)$$

where the estimates of $\gamma_{l,A}$ capture the impact of a range of sociodemographic characteristics of person *n* in Wave A ($z_{n,A}$) on the latent attitude, and where $\xi_{l,n,A}$ is a standard Normal variate (mean of 0, standard deviation of 1), distributed across respondents, capturing the random element of the latent attitude.

The corresponding latent attitude in Wave B is specified as:

$$\alpha_{l,n,B} = \omega_{l,A}\alpha_{l,n,A} + (1 - \omega_{l,A})(\gamma_{l,B} z_{n,B} + \xi_{l,n,B}) \qquad (4)$$

where $\omega_{l,A} = \frac{1}{1+e^{-\kappa_{l,A}}}$, with $\kappa_{l,A}$ being estimated. If $\omega_{l,A}$ tends towards 1, the latent attitude *l* is stable across the two waves, if it tends to zero, the value in Wave B is independent from the value in Wave A. We impose the variance of the random component to be constant across waves.

We interact the latent attitude with coefficients in the choice model, e.g. for attribute *k* in Wave A for person *n* and latent attitude *l*, we would use:

$$\beta_{A,k,n} = \beta_{A,base,k} + \tau_{A,l}\alpha_{l,n,A} \quad (5)$$

The same latent variables are then used to explain the answers to various attitudinal questions. In this exploratory work, we rely on a continuous treatment, where we subtract the mean from the indicators to avoid the need to estimate a constant. We thus write, for indicator k in Wave A and person n, assuming an impact by latent attitude *l*:

$$\mathrm{I}_{\mathrm{knA}} = \zeta_{\mathrm{kA}}\alpha_{l,n,A} + \upsilon_{\mathrm{kn}} \quad (6)$$

where υ_{kn} is standard Normal.

The probability for this indicator, say $L_{Ink,A}$, is then given by $\phi(\mathrm{I}_{\mathrm{knA}})$, where ϕ is the normal density. The final likelihood function has four components, explaining the set of T_A and T_B choices in both waves, and the answers to the set of K_A and K_B attitudinal questions in both waves. We have that, for person *n*,:

$$L_n = \int_\alpha \prod_{t=1}^{T_A} \frac{e^{V_{i_{n,t,A}}}}{\sum_{j=1}^{3} e^{V_{\mathrm{j,n,t,A}}}} \prod_{t=1}^{T_B} \frac{e^{V_{i_{n,t,B}}}}{\sum_{j=1}^{3} e^{V_{\mathrm{j,n,t,B}}}} \prod_{k=1}^{\mathrm{K_A}} L_{Ink,A} \prod_{k=1}^{\mathrm{K_B}} L_{Ink,B}\, f(\alpha) d\alpha \quad (7)$$

where this is integrated over the distribution of all latent attitudes. Figure 1 illustrates the structure of this model.

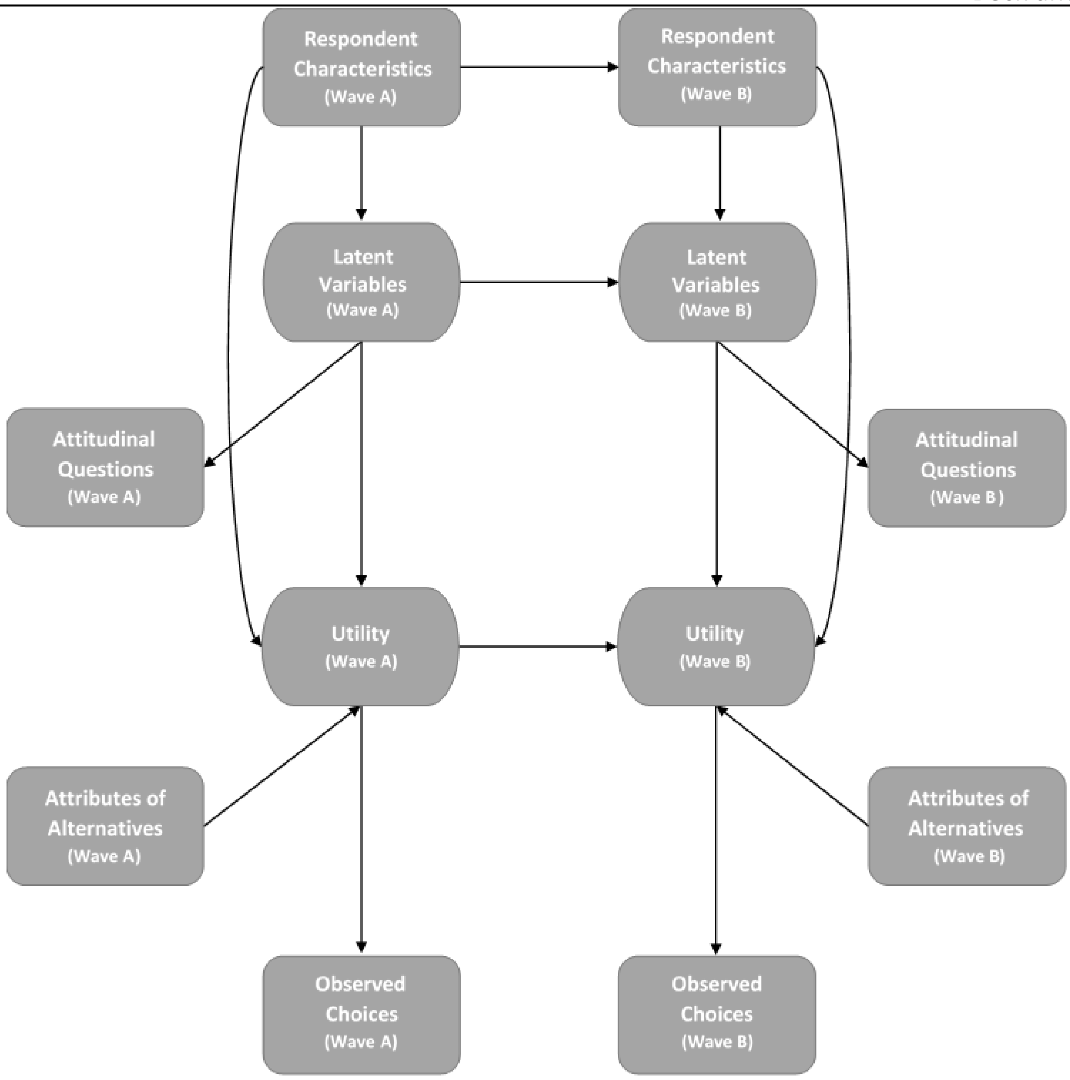

FIGURE 1 Structure of Hybrid Model

3. EMPIRICAL CONTEXT

A survey investigating preferences and attitudes towards the security screening process inherent in international travel via aircraft was conducted in Sydney, Australia at two separate points in time. The first wave was collected in early August 2014 following almost immediately after the MH17 incident in July and shortly after MH370 in March. The second wave was conducted on 18 December 2014, two days after the Sydney siege. The attitudinal questions and content of the choice tasks were developed in conjunction with airline and airport managers based on what they considered to be managerially relevant, and refined using a pilot survey on a convenience sample of Master's level students. Additionally, based on the work of (*10*) we use both a "Distrust Index" and a "Privacy Index" to assess attitudes. The specific attitudinal questions can be seen in Table 1 on the following page.

In the choice tasks, a respondent was asked to imagine that they were making an international flight and given the two different hypothetical security processes that were presented with, identify the process that was most acceptable to them, where they also had the option not to travel. The attributes broadly covered all aspects of the security process, from pat-downs and scanning, to x-ray of luggage, identity verification, extra time, costs and greater threat detection. As it is not directly relevant to the attribute levels used in the experiment is provided in an appendix. Current security practice in Australia was used as the base for all attributes, with levels involving increasingly more strict procedures. A total of 157 respondents completed surveys in both waves. These respondents received identical choice tasks in both surveys, completing a total of 6 choice tasks per wave. In generating the design for the survey, the responses from the pilot study were used as priors and, using uniform distributed priors to account for the expected directions of the parameters, a Bayesian D-efficient design based on an MNL model was constructed (*22*).

Respondents were recruited from an online consumer panel from the Greater Sydney region. Only respondents 18 years or older were sampled. Among the respondents which completed both waves of the survey, the average age of 55.5 years (standard deviation of 14.3) is higher than expected, but is not too dissimilar from the average age of 47.6 years for similar individuals in the Greater Sydney region, and the sample median income of $46,300 also compares well to the region average of $53,000 (*23*). The sample has a higher number of male respondents than expected (61 percent). Ninety-one percent of respondents travel for leisure, with nine percent travelling for business which is consistent with other studies in this geographic region (see e.g. *24*). The average age and income in the second wave is very slightly higher than in the first wave, showing some small evolution of the sample, though large differences are not expected given the survey was conducted only five months apart.

4. RESULTS

4.2 Stability of attitudes over waves

In total there were twelve questions focusing on various aspects of safety and security related to international flights, where strength of agreement with each statement was measured on a seven-point scale (1 = Strongly Disagree; 7 = Strongly Agree). Additional to these questions were seven attitudinal statements focusing on attitudes towards privacy and trust. In line with (*10*) these questions were measure on a four-point scale (1= not at all important to 4 being very important). Table 1 displays the questions asked, along with summary statistics of the responses.

TABLE 1 Changes in Responses to the Attitudinal Questions

Safety and Security	Change in Response between waves			Wave A		Wave B		S.E. of Mean Diff.	t-diff
	Lower	Same	Higher	Mean	Stdev	Mean	Stdev		
I find that I have to spend too much time at airports waiting in lines	24%	48%	29%	4.30	1.37	4.40	1.41	1.35	-0.949
So long as I don't miss my fight, spending time in lines is not a problem for me	36%	37%	27%	4.64	1.39	4.49	1.34	1.59	1.156
On a connecting flight if I should not have to be re-screened	25%	39%	36%	4.90	1.56	5.04	1.54	1.55	-1.079
Overall I feel safe when on-board an aircraft	20%	48%	31%	5.10	1.23	5.22	1.31	0.97	-1.564
Mechanical issues are a significant threat to the safety of my flight	29%	38%	32%	4.12	1.59	4.27	1.59	1.57	-1.217
Other passengers are a significant threat to the safety of my flight	29%	44%	27%	4.00	1.33	4.01	1.39	1.28	-0.062
Airline staff (pilots/cabin crew/ground) are a significant threat safety of flight	28%	41%	31%	2.84	1.37	2.89	1.55	1.40	-0.456
I feel that airlines and authorities currently do enough to make air travel safe	19%	42%	39%	4.78	1.25	5.12	1.20	1.31	***-3.279***
I feel that airlines and authorities do enough to minimise mechanical threats	27%	48%	25%	4.91	1.20	4.79	1.41	1.27	1.191
I feel that airlines and authorities do enough to minimise threats from passengers	21%	50%	29%	4.87	1.22	4.99	1.13	1.19	-1.275
I feel that airlines and authorities do enough to minimise threats from staff	23%	44%	33%	5.07	1.22	5.19	1.18	1.19	-1.275
Visible Australian Federal Police officers in the airport make me feel more secure	25%	46%	29%	5.11	1.37	5.14	1.38	1.07	-0.373

Privacy and Trust	Change in Response between waves			Wave A		Wave B		S.E. of Mean Diff.	t-diff
	Lower	Same	Higher	Mean	Stdev	Mean	Stdev		
Protecting the privacy of my personal information is…	22%	55%	23%	3.34	0.82	3.35	0.71	0.87	-0.301
Taking action against important security risks (e.g. terrorism, organised crime) is…	7%	83%	10%	3.72	0.67	3.73	0.62	0.56	-0.665
Defending current liberties and human rights is…	18%	53%	29%	2.97	0.94	3.13	0.81	0.95	***-2.191***
Technology has almost got out of control…	18%	53%	29%	2.22	0.98	2.37	0.98	1.03	***-1.895***
Government can generally be trusted to look after our interests…	24%	49%	27%	2.41	0.89	2.39	0.87	1.05	0.001
The way one votes has no effect on what the government does…	24%	46%	29%	2.76	1.03	2.85	0.95	1.20	-0.986
In general business helps us more than it harms us…	22%	52%	26%	2.53	0.83	2.62	0.76	1.15	-1.195
I trust authorities to adequately protect my private information…	24%	48%	28%	2.45	0.89	2.48	0.86	1.11	-0.473

Confirmatory factor analysis was performed prior to modelling choices to gain preliminary insight into what latent constructs may underlie the responses to the attitudinal questions. Initially factor analysis was performed on all attitudinal questions together (though each wave was treated separately), however the safety questions and privacy and trust questions consistently loaded onto different factors, so the question sets were treated separately. Bartlett's test of sphericity revealed the loadings to be robust, confirming the existence of three underlying dimensions for each set of attitudinal questions, where crucially, these are identical across the two waves. These factors are summarised in Table 2.

TABLE 2 Underlying Factors for Attitudinal Responses For Both Waves

Safety 1: Flying is Safe
S1) Overall I feel safe when on-board an aircraft
S2) Airlines authorities currently do enough to make air travel safe
S3) Airlines authorities do enough to minimise mechanical threats
S4) Airlines authorities do enough to minimise threats from passengers
S5) Airlines authorities do enough to minimise threats from staff
S6) Visible Australian Federal Police in the airport make me feel more secure
Safety 2: Threats
S7) Mechanical issues are a significant threat to the safety of my flight
S8) Other passengers are a significant threat to the safety of my flight
S9) Airline staff (pilots/cabin crew/ground) are a significant threat safety of flight
Safety 3: Time
S10) I find that I have to spend too much time at airports waiting in lines
S11) So long as I don't miss my fight, spending time in lines is not a problem for me
S12) On a connecting flight if I should not have to be re-screened
Privacy 1: Trust Business and Government
P1) Government can generally be trusted to look after our interests…
P2) In general business helps us more than it harms us…
P3) I trust authorities to adequately protect by private information…
Privacy 2: Concern
P4) Protecting the privacy of my personal information is…
P5) Taking action against important security risks (e.g. terrorism, organised crime) is…
P6) Defending current liberties and human rights is…
Privacy 3: Distrust Business and Government
P7) Technology has almost got out of control…
P8) The way one votes has no effect on what the government does…

Interestingly, very little difference is found in factor scores across socio-demographic segments: in the first wave only weak correlations between age exist for *Safety 1* (+) and *Privacy 3* (-), males score higher on average for Safety 1 and income is weakly correlated with *Privacy 2* (+); in the second wave, weak correlations exist between age and *Safety 1* (+), *Privacy 2* (+) and *Privacy 3* (-), and between income and *Privacy 1* (+) and *Privacy 2* (-). Overall, this finding is not surprising as attitudes are generally seen as intrinsic and shaped by a person's experiences rather than their observable characteristics.

4.2 Preliminary insights into the change in preferences

Each choice task allowed respondents to state that they would not travel under the two security regimes proposed, but they were then asked to indicate which of the two options they preferred if travel was compulsory. For the purposes of this paper, we focus on the binary choice only (i.e. between the two travel options), but we allow for a difference in scale (i.e. variance of the error) between choices in which a respondent chose to travel and those where the initial preference was not to travel. Initially the choices made by each respondent in the first wave were compared to the choices made in the second wave in the same scenario. In 66% of choice tasks, an identical choice was made and 62% of respondents gave the same response in four or more choices tasks. This indicates a high degree of consistency in choices, especially given that respondents were asked to complete six choice tasks, with each alternative containing nine attributes with multiple levels, and that the surveys were conducted five months apart in the aftermath of two different but salient events.

To generate some initial insights, we estimate a base model in which the factor scores (i.e. not just the answers to attitudinal questions) were used as additional explanators. This thus uses a sequential approach, where the factor scores are estimated on the basis of the answers to attitudinal questions alone, without any influence by the choice data. The results of this preliminary modelling are displayed in Table 3 and Table 4. Note that all interactions were trialled in each model for each wave, for every factor and every level of each attribute, resulting in over 100 exploratory models. Only the significant interactions are presented. In addition to the analysis of the individual waves, preliminary modelling was also done on the pooled data. Initially the coefficients for the second wave were specified as a function of the parameters in Wave A, plus a "shift" parameter that enabled us to test if the sensitivities to the attributes had shifted in Wave B by a significant amount. As can be seen in Table 4, the only variables for which there was a significant change in sensitivities were for the digital technology aspects of the security process; namely respondents showed an increased preference from Wave A to Wave B for whole of body scans for all passengers, standard CCTV cameras and CCTV with facial recognition software. It should be noted that log-likelihood ratio tests revealed no significant loss in model fit as a result of restricting the parameters to be equal across the waves, to letting them be freely estimated in a joint model or to estimating them in two separate models. This informed us that pooling the data was appropriate for this analysis.

The pooled data model show that there are no significant differences in scale (i.e. error variance) between first preferences and forced choice, or across the two waves. All of the coefficients are of the expected sign; respondents dislike extra time and money spent on security, the prefer better threat detection, and they like the use of CCTV cameras. The shift parameters indicate that preferences for CCTV technology and whole of body scanning is significantly larger in Wave B relative to Wave A choices.

Table 4 displays the significant interactions with factor scores across these three models. While any interpretation of these direct interactions should be treated with caution, it is instructive to note that while each model has numerous significant interactions, indicating that the latent factors underlying the attitudinal scores are impacting on choice, only four of the interactions are significant in more than one model and none of the interactions are significant across all models. This behaviour suggests that while choices and attitudes are stable, the impact of attitudes on choices is relatively more variable. Of particular note is that in the first wave of the survey the majority of significant interactions were with the privacy and trust questions, however in the second wave of the experiment none of these variables interacted significant and a greater share of the safety and security questions could help explain the choices. Additionally, the majority of factors that are significant in the pooled data are from those formed in the first wave of the survey, suggesting that these constructs may be more strongly held over time, or a truer basis of underlying attitudes.

TABLE 3 MNL Models with Direct Interactions

	WAVE A		WAVE B		POOLED DATA	
	Rho-sq	0.43	**Rho-sq**	0.44	**Rho-sq**	0.44
	LL	-562.44	**LL**	-560.87	**LL**	-1127.82
	Beta	***Robust t***	***Beta***	***Robust t***	***Beta***	***Robust t***
Scale forced choice (1st Wave) [a]	0.841	-0.66	---	---	0.958	-0.15
Scale forced choice (2nd Wave) [a]	---	---	1.561	1.15	1.238	0.65
Scale Second Survey Choices [a]	---	---	---	---	0.803	-1.57
ASC for first alternative	0.043	0.37	0.115	1.31	0.121	1.32
X-ray with targeted opening	---	---	---	---	---	---
X-ray with random opening	-0.062	-0.48	0.147	1.35	0.036	0.39
X-ray and all opened	0.072	0.43	0.326	2.18	0.198	1.48
Partial pat-down (current practice)	---	---	---	---	---	---
Thorough pat-down for targeted passengers	-0.038	-0.31	-0.126	-1.19	-0.146	-1.48
Thorough pat-down for all passengers	-0.159	-1.12	-0.163	-1.19	-0.228	-1.95
Metal detector for all passengers	---	---	---	---	---	---
Whole of body scan for targeted passengers	0.023	0.13	0.193	1.31	0.120	0.89
Whole of body scan for random passengers	0.158	0.78	0.236	1.20	0.208	1.33
Whole of body scan for all passengers	0.113	0.52	0.693	3.41	0.172 *	0.83
No CCTV	---	---	---	---	---	---
Standard CCTV cameras	0.373	2.09	0.768	4.46	0.367 *	2.24
CCTV cameras with facial recognition	0.383	2.45	0.761	4.93	0.387 *	2.59
Passport (current practice)	---	---	---	---	---	---
Passport with finger print and/or retinal scan	0.222	1.82	0.054	0.50	0.179	1.73
Passport with DNA verification	-0.032	-0.20	-0.158	-1.09	-0.138	-1.15
Time at Security	-0.005	-1.37	-0.007	-2.6	-0.007	-2.63
No security personnel on-board	---	---	---	---	---	---
Undercover security on-board flight	0.473	3.66	0.375	3.51	0.501	4.50
Uniformed security on-board flight	0.11	0.64	0.303	1.90	0.220	1.66
Extra cost for Security	-0.009	-5.23	-0.007	-4.59	-0.009	-6.25
Number of incidents avoided	0.038	3.63	0.014	1.61	0.029	3.39

Shift in preference for thorough pat-down for all passengers	0.533*	2.44
Shift in preference for Standard CCTV	0.564*	2.52
Shift in preference for CCTV with facial recognition	0.539*	2.18

[a] *The t-test for the scale parameters are against a value of one.*
** Note that these parameters are the sensitivities based on the Wave A, with the shift parameter measuring how much these parameters changed in Wave B.*

TABLE 4 Interactions Between Factors and MNL Parameters

	WAVE A		WAVE B		POOLED DATA	
	Beta	***Robust t***	***Beta***	***Robust t***	***Beta***	***Robust t***
Safety 1 * WBS for all	---	---	-0.332	-2.46	---	---
Safety 1 * Passport and fingerprint	---	---	-0.193	-2.02	---	---
Safety 2 * Passport with DNA	0.256	1.85	---	---	0.238^{1}	2.41
Safety 2 * Time	---	---	-0.006	-2.42	---	---
Safety 2 * Uniformed security	---	---	-0.194	-2.32	---	---
Safety 3 * Thorough pat-down for all	-0.231	-2.91	---	---	-0.248^{1}	-3.07
Safety 3 * Time	---	---	---	---	-0.006^{2}	-2.41
Safety 3 * Undercover Security	---	---	0.160	2.12	0.351^{2}	3.67
Safety 3 * Incidents avoided	0.016	1.86	---	---	---	---
Privacy 1 * Incidents avoided	0.019	1.94	---	---	---	---
Privacy 2 * Cost	-0.003	-2.10	---	---	-0.002^{1}	-2.01
Privacy 2 * Incidents avoided	0.019	2.10	---	---	---	---
Privacy 3 * Standard CCTV	-0.318	-1.86	---	---	-0.259^{1}	-1.60
Privacy 3 * Facial recognition CCTV	-0.526	-3.21	---	---	-0.484^{1}	-3.12

The superscript indicates whether the underlying attitudinal dimension is from attitudes indicated in the first or the second wave of the survey.

4.3 Multi-wave choices in the hybrid framework

The earlier results were used as a starting point for the examination of changes in the choices made via the hybrid model framework. The latent dimensions *Safety 1* and *Privacy 1* did not significantly impact on choices made in the pooled data and we also saw that neither had a significant role in the hybrid model. Table 5 displays the results from the simultaneous hybrid model including the latent variables which did have an impact in the pooled data MNL.

Recal that the specification of the hybrid choice model included a weighting parameter κ that allowed us to test if the latent variable underlying the responses in each wave was stable. We allowed for this by specifying two independent latent variables for each wave and then making the latent variable in the second wave a weighted function of the two latent variables. If this weighting parameter went to one it indicated that the latent variable in the second survey was the same as the first, whereas if the weighting parameter went to zero it indicates that the latent variable in the second wave was not related to the first. For the *Safety 1*, *Safety 2* and *Privacy 3* dimensions, it was found that the weighting parameter was not significantly different to one, indicating that the latent variables in the second wave were not significantly different to those in the first wave. For the Privacy 2 construct, however the κ parameter is not significantly different to zero meaning that the weight parameter for this latent construct is equal to ~ 0.5; noting that the weighting parameter is equal to $1/(1+e^{-\kappa})$. This result indicates that there has been a shift in the underlying attitude towards the protection of society's current liberties and protecting society from terror.

TABLE 5 Hybrid Choice Model of Wave A and Wave B

Choice Parameters	**Beta**	**Rob.t**
Forced Choice Scale (1st Wave)	0.995	-0.01*
Forced Choice Scale (2nd Wave)	1.260	0.55*
Scale for Second Survey Choices	0.860	-1.11*
ASC for first alternative	0.063	0.72
X-ray with random opening	0.030	0.34
X-ray and all opened	0.200	1.48
Thorough pat-down for targeted passengers	-0.130	-1.41
Thorough pat-down for all passengers	-0.200	-1.72
Whole of body scan for targeted passengers	0.100	0.71
Whole of body scan for random passengers	0.200	1.31
Whole of body scan for all passengers	0.220	1.10
Standard CCTV cameras	0.370	2.28
CCTV cameras with facial recognition	0.390	2.57
Passport with finger print / retinal scan	0.150	1.43
Passport with DNA verification	-0.130	-1.14
Time at Security	-0.010	-2.29
Undercover security on-board flight	0.450	4.02
Uniformed security on-board flight	0.190	1.45
Extra cost for Security	-0.010	-5.97
Number of incidents avoided	0.030	2.91
Shift in Sensitivity Between Surveys		
Shift for Whole of Body (All)	0.490	2.46
Shift for standard CCTV	0.500	2.36
Shift for CCTV with facial recog.	0.470	1.96
Impact of Socio's on Latent Variables		
Safety 2; Male	0.020	0.07
Safety 2; Age	0.0001	0.06
Safety 3; Male	0.210	0.77
Safety 3; Age	0.000	-0.77
Privacy 2; Male 1	-0.370	-1.54
Privacy 2; Male 2	-0.260	-0.64
Privacy 2; Age 1	0.010	0.97
Privacy 2; Age 2	0.010	0.90
Privacy 3; Male	0.150	0.58
Privacy 3; Age	-0.0001	-0.56
Shift in Latent Variable		
κ - Privacy 2	0.480	1.18
Impact of Latent Variables		
τ - Safety 3 * All pat-down	-0.150	-0.89
τ - Privacy 3 * CCTV standard	-0.240	-1.04
τ - Privacy 3 * CCTV facial recog	-0.490	-2.55
τ - Safety 2 * Passport + DNA	0.290	1.71
τ - Privacy 2 * Undercover Sec.	0.200	1.37
τ - Safety 3 * All pat-down	-0.120	-0.51
τ - Privacy 3 * CCTV standard	-0.250	-1.26
τ - Privacy 3 * CCTV facial recog	-0.220	-0.87
τ - Safety 2 * Passport + DNA	0.220	1.44
τ - Privacy 2 * Undercover Sec.	0.180	0.53
Loglikelihood - Final Model	-6131.642	
Loglikelihood - Choice Model	-1154.806	
Number parameters	88	

Measurement Model For Indicators	**Beta**	**Rob. t**
Safety 2: Threats - Wave A		
ζ - S7 - Mechanical	1.095	6.5
σ - S7 - Mechanical	1.223	11.73
ζ - S8 - Other Pass.	0.958	6.19
σ - S8 - Other Pass.	0.984	12.7
ζ - S9 - Staff	0.943	5.38
σ - S9 - Staff	1.055	12.73
Safety 2: Threats - Wave B		
ζ - S7 - Mechanical	0.970	-5.59
σ - S7 - Mechanical	1.315	11.58
ζ - S8 - Other Pass.	1.011	-6.77
σ - S8 - Other Pass.	1.032	9.87
ζ - S9 - Staff	0.787	-3.77
σ - S9 - Staff	1.367	15.24
Safety 3: Time - Wave A		
ζ - S10 - Wait	0.852	3.98
σ - S10 - Wait	1.110	8.4
ζ - S11 - Not miss	-0.378	-1.68
σ - S11 - Not miss	1.334	15.07
ζ - S12 - Re-screen	0.798	2.27
σ - S12 - Re-screen	1.360	8.27
Safety 3: Time - Wave B		
ζ - S10 - Wait	0.849	2.8
σ - S10 - Wait	1.159	6.06
ζ - S11 - Not miss	-0.493	-2.47
σ - S11 - Not miss	1.257	13.91
ζ - S12 - Re-screen	0.700	3.5
σ - S12 - Re-screen	1.384	12.13
Privacy 2: Concern - Wave A		
ζ - P4 - Info.	0.664	-5.95
σ - P4 - Info.	0.538	7.37
ζ - P5 - Security	0.211	-1.92
σ - P5 - Security	0.641	8.41
ζ - P6 - Liberties	0.630	-5.07
σ - P6 - Liberties	0.728	10.55
Privacy 2: Concern - Wave B		
ζ - P4 - Info.	0.692	-4.64
σ - P4 - Info.	0.529	8.54
ζ - P5 - Security	0.305	-1.94
σ - P5 - Security	0.578	7.32
ζ - P6 - Liberties	0.729	-3.18
σ - P6 - Liberties	0.636	6.26
Privacy 3: Distrust - Wave A		
ζ - P7 - Tech.	0.744	6.35
σ - P7 - Tech.	0.653	5.42
ζ - P8 - Vote	0.367	2.43
σ - P8 - Vote	0.964	16.46
Privacy 3: Distrust - Wave B		
ζ - P7 - Tech.	0.665	7.04
σ - P7 - Tech.	0.725	9.42
ζ - P8 - Vote	0.248	1.43
σ - P8 - Vote	0.918	16.86

* The t-test for the scale parameters are against a value of one.

The stability of the latent attitudes is also reflected in the ζ parameters, which measure the impact of the latent attitudes on the indicators. For the *Safety 1*, *Safety 2* and *Privacy 3* latent variables, the impact of these constructs on the indicators is very similar in the first survey and in the second survey. On the other hand, the ζ parameters for the *Privacy 2* latent variables are all higher in the second wave, indicating that respondents who are concerned are even more likely to find protection of personal data, civil liberties and society from security risks to be important after a terrorist attack, which is intuitive.

Addressing the choice parameters which are consistent across the two waves of the survey, there is a weakly significant preference for all luggage to be x-rayed and opened, the use of thorough pat-downs in any context is consistently seen to be a negative, and there is a consistent preference for the presence of security and in particular undercover security on-board flights. Finally, respondents desire to avoid extra time and extra cost, but also consistency prefer more threats to be detected. Of interest are the shift parameters, which indicated that preferences for whole of body scans and CCTV became significantly stronger in the second wave relative to the first.

The τ parameters show how the latent variables impact on the choice parameters. The *Privacy 3* latent variable significantly impacts on preferences in Wave A for the use of CCTV cameras, but interestingly the impact of this latent variable is diminished in Wave B. This could potentially be related to the shift in *Privacy 2* across waves, and CCTV technology is now more important overall (as witnessed by the significant increase in the weight of these parameters in Wave B relative to Wave A), whereas previously those who were distrustful of business and government and thus did not like being recorded are now prepared to tolerate this because of increased concern for society. The *Safety 2* latent variable shows that those with a higher underlying feeling of their being threats to flying prefer identification processes that require DNA samples in both the first and second waves of the survey indicating that the impact of this attitude on choice is consistent over time. Finally, the *Privacy 2* latent construct itself, which varies over time periods, also varies in the interaction with the choices in the two time periods with respect to preference for undercover security. The influence of this latent attitude on choices was marginally significant in the first wave, while it is not significant in Wave B. Again, this might be viewed as a shift in the overall level of concern between the two waves having expressed itself as an increased preference for better technology to detect a threat before getting on the plane.

5. DISCUSSION AND CONCLUSION

In this paper we have explored the role that attitudes play on the preferences for security protocols within a hybrid modelling framework, in the aftermath of two very different disasters; the mysterious disappearance / catastrophic destruction of a plane and an isolated terror event in a CBD region. The framework we propose allows the analyst to test if latent attitudes are the same or if they differ over time periods, and also allows the latent attitudes to impact in different ways on the indicators which measure those latent dimensions. What is interesting in the context of this study is that the majority of the choice parameters are not significantly different across the waves and the latent attitudes also remain largely unchanged from the first round. This suggests that in the context of preferences for security in air travel, preferences and attitudes are stable over time, despite extreme external circumstances.

Where we do observe a difference it is with respect to the latent construct that we have interpreted as concern for society, with people seemingly more concerned in the second wave following a terror attack – but this concern is not entirely independent of the initial latent construct. This suggests that this change may be a small disturbance to what are otherwise largely robust latent attitudes, thus is would be interesting to see if this disturbance regresses back to the initial measurement over time. Nonetheless, this increased concern in the second wave may explain some of the differences we observe in choices, in particular the increased preference for greater electronic surveillance, but does not interact with choices in a direct way. Future research will seek to examine the nature of the choice sets where different choices were made, to try and understand in greater detail what might have prompted those changes – for example are changes in choices a function of one particular attribute being significantly more or less important for one particular level of that attribute?

Overall, these results suggest that choices, latent attitudes underlying choices and the way in which those attitudes are expressed on measurement scales are stable even in the most extreme of circumstances. This alone is a very interesting finding and more work should be done to understand if this is also the case across a range of different contexts; one would hypothesise there to be greater variability in choices which require less consideration or over which views are not as well formed. While there is some satisfaction in finding a great degree of stability in choices and underlying attitudes, there are two issues that might be troubling about these results. Firstly, if preferences and attitudes are not greatly variable in this dramatic context, then what does this mean for policy makers who wish to change attitudes and choices in less extreme circumstances? Secondly, and perhaps more fundamentally, there is some evidence that different latent attitudes impact the choices in different ways in different time periods, even though the formation and measurement of these dimensions are stable across the two time periods. This suggests that people are making similar choices but potentially rationalising or justifying those same choices in quite different circumstances by calling on different attitudinal constructs or in other words choices attitudes are potentially predicated on choices in this context.

In concluding, we return to the discussion of (*21*) who argue that while changes in choices may be the result of changes in attitudes, it cannot be ruled out that changes in attitudes are manipulated to justify changes in choice. While this is a first attempt and more work is needed in this area, the framework proposed herein has been shown to model choices and attitudes jointly within a hybrid framework, and detect subtle shifts in the choices and the formation of latent attitudes over time. In doing so, this paper provides some evidence that even though the choices are largely consistent in each wave of the survey, the impacts of the latent variables on those choices are not. While many previous stated preference studies have found significant relationships between choices and attitudes, the assumption is that attitudes influence choice. It may well be that in some instances, these assumptions are misguided; that choices are constant and attitudes are varied to accommodate those choices. In light of this, we strongly encourage more research into the stability choices and attitudes over time, in a wide range of contexts.

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APPENDIX

Attributes and Levels for Choice Tasks

Attribute	Levels
The level of security screening for luggage	X-ray with luggage opened for targeted cases only (current practice)
	X-ray with luggage opened randomly
	X-ray with all luggage opened
The level of physical screening for passengers	Partial pat-down (current practice)
	Thorough pat-down for targeted passengers only
	Thorough pat-down for all passengers
The level of computer-based screening for passengers	Metal detector for all passengers (current practice)
	Whole of body scan for targeted passengers only
	Whole of body scan for random passengers
	Whole of body scan for all passengers
The level of camera technology used	None
	Standard CCTV cameras
	CCTC cameras with facial recognition
The level of identity verification required	Passport (current practice)
	Passport with finger print and/or retinal scan
	Passport with DNA verification (e.g., hair or saliva sample)
Average time required to complete security and immigration	10 minutes
	20 minutes
	40 minutes
	60 minutes
Presence of security on-board the aircraft	No security personnel on-board
	Undercover security personnel on-board flight
	Uniformed security personnel on-board flight
Increased cost of ticket to cover security processes	$75
	$100
	$150
	$200
Number of incidents avoided by security process	1 every 10 years
	5 every 10 years
	10 every 10 years
	20 every 10 years