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A comparison of alternative conjoint analysis formats in non-hypothetical settings to elicit preferences and willingness to pay

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Conjoint Analysis

- Conjoint Analysis (CA) has become one of the most popular research tools to elicit consumer's preferences and WTP.

- CA is a stated preference method that involves participants to rate, rank or choose between competing products or alternatives.

Conjoint Analysis

- CA has been frequently used in different disciplines such as:

  - **Marketing** (Ding et al., 2005; Alfnes et al., 2006; Ding, 2007; Chang et al., 2009; Dong et al., 2010)
  - **Agricultural economics** (Scarpa et al., 2004; Lusk et al., 2008; Corrigan et al., 2009; Menapace et al., 2011)
  - **Environmental Economics** (Hanley et al., 1993; Boyle et al., 2001; Caparrós et al., 2008; Campbell and Lorimer, 2009; Scarpa et al., 2011)
  - **Transport** (Hensher and Greene, 2003; Greene et al., 2006; Louviere et al., 2008; Greene and hensher, 2013)
  - **Health Economics** (Louviere et al., 2010; Flynn et al., 2010; De Bekker et al., 2012; Lancsar et al., 2013).

Choice Experiment

Three main conjoint formats:

1. **Choice Experiments (CE):** respondents are shown a set of combinations of attributes and are asked to indicate which of the combinations they <u>would purchase</u>.

    (+)   Closely mimics the purchasing process

    (-)   Does not provide information about non-chosen profiles

Choice Experiment

Figure 1: An example of a choice set presented in CE

Choice set 1			Identification number: ………			
	OLIVE 1	**OLIVE 2**	**OLIVE 3**	**OLIVE 4**	**OLIVE 5**	**OPTION "NONE"**
Type: **Brand:** **Origin:** **Price:**	Virgin Private Andalusia 3.50	Olive oil Private Andalusia 3.50	Olive oil Manufacturer Rest of Spain 4.80	Virgin Extra Manufacturer Catalonia 4.80	Virgin Extra Manufacturer Catalonia 2.20	None of them
	☐	☐	☐	☐	☐	☐
Please mark the option you would choose.						

Ranking Conjoint Analysis

2. **Ranking Conjoint Analysis (RCA):** respondents are also presented with a set of profiles but they are asked to order them from the <u>most preferred</u> to the <u>least preferred</u>.

   (+) Does provide information about non-chosen profiles

   (-) The complexity of the ranking task increases substantially with the number of profiles to be ranked.

Ranking Conjoint Analysis

Figure 2: An example of a choice set presented in RCA

Choice set 1			Identification number: ………			
	OLIVE 1	**OLIVE 2**	**OLIVE 3**	**OLIVE 4**	**OLIVE 5**	**OPTION "NONE"**
Type : **Brand:** **Origin:** **Price:**	Virgin Private Andalusia 3.50	Olive oil Private Andalusia 3.50	Olive oil Manufacturer Rest of Spain 4.80	Virgin Extra Manufacturer Catalonia 4.80	Virgin Extra Manufacturer Catalonia 2.20	None of them
	1st 2nd 3rd 4th 5th	1st 2nd 3rd 4th 5th	1st 2nd 3rd 4th 5th	1st 2nd 3rd 4th 5th	1st 2nd 3rd 4th 5th	
Please Rank the option 1-5 from the most preferred to the least preferred **or** mark the option None						

What we should know?

Issues that arise from the literature review:

1. **Public versus private goods**: most of the comparison has been carried out in the environmental economics literature: **What about market goods?**

2. **Hypothetical versus non-hypothetical settings**: it is well known that in absence of any moral and/or monetary costs that prevent subjects from deviating from their actual behavior, participants in hypothetical elicitation methods will be incentivized to not put enough cognitive effort into the elicitation tasks and not reveal their true preferences and values (Lusk and Shogren, 2007).

3. **No comparison with BWS:** in spite of its expected superiority in terms of realism and ease of its implementation.

4. **Sensitiveness to the number of alternatives in each choice set.**

As the number of alternatives increases:

- Differences between the products can decrease making more difficult for respondents to identify the most preferred option, leading to an increase in dissatisfaction, regret and even a choice deferral altogether.

- Consumers may need to invest additional time and effort which can reduce the enjoyment and satisfaction that can be derived from making choices.

- Consumers may perceive foregone benefits from not choosing the other "non-chosen" options.

- The validity of results can decrease since it can incentivize consumers to avoid difficult tradeoffs by delaying the choice decision or by choosing the "non-choice" or "status quo" option.

- Difficulties may increase in RCA and BWS

5. **Most preferred versus full rank information**. Most of literature recode RCA as a CE. However, Louviere et al. (2008) and Chang el al. (2009) found that the rank order model lead to more efficient estimates when the full ranking information is used in the estimation of econometric models.

6. **Disaggregate models versus aggregate models**. Disaggregate models could capture heterogeneity effects: Random Parameter or Hierarchical Bayesian Multinomial Logit models

7. **External validity of estimates**. Comparisons have been made considering estimated partworths and WTP measures. Need to account for differences in:

    - External validity of results by including a non-hypothetical holdout task
    - Consistency of respondents' answers by repeating one choice set

New insights

- ## Our experiment:

    - Market good: Combo (sandwich plus drink)

    - Non-hypothetical experiment

    - Assessment of the equivalence between Choice Based Conjoint Analysis (CBCA≈CE) and RCA in relatively <u>small</u> and <u>large</u> choice set settings

    - RRCA (RCA recoded as CE)

    - External validity with the inclusion of the holdout task

    - Estimation procedure: Hierarchical Bayesian Multinomial Logit Model

    - Population: Students

Experimental design

Table 1: Treatments

	Treatment 1		Treatment 2	
	NH-CBCA	NH-RCA	NH-CBCA	NH-RCA
Number of choice sets	16	16	16	16
Number of options	4	4	8	8
Number of tasks	2	2	2	2
Number of participants	43	43	46	46

Experimental design

Table 2: Attributes and attributes' levels

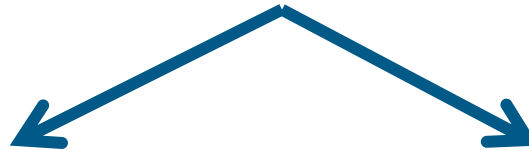| Attributes	Drinks	Sandwich	Price
Attributes' levels	Water	Vegetarian	3.35 €
	Juice	Omelet	3.80 €
	Light coke	Hamburger	4.30 €
	Classic coke	Frankfurt	4.75 €

⬇

64 Combinations

⬇

Orthogonal design: 16 Combinations

Experimental design

Street and Burgess (2007): Generators

Treatment 1: 4 options

Option 2: (1, 1, 1)
Option 3: (3, 3, 3)
Option 4:   None

Treatment 2: 8 options

Option 2: (1, 1, 1)
Option 3: (3, 3, 3)
Option 4: (2, 2, 2)
Option 5: (0, 2, 3)
Option 6: (1, 3, 0)
Option 7: (3, 0, 2)
Option 8:   None

Experimental design

- In both treatments, the two CA formats were conducted in four steps:

  - **Step 1**: after taking a seat and given a welcome address, each participant received an envelope which contained 10 Euros as compensation for their participation

  - **Step 2**: participants in both CA formats were informed that they would be participating in two *non-hypothetical* tasks (i.e., main task and holdout task) and we explained to them why it is in their best interest to reveal their actual preferences, given the non-hypothetical nature of the experiment.

  - **Step 3**: participants were successively shown a choice set in each round. Since there are 16 choice sets, we have a total of 16 rounds.

  - **Step 4:** participants in both treatments were given a choice set of 9 options (holdout task) and were then asked to choose one of them.

Experimental design

Figure4: An example of a choice set presented in NH-CBCA (Treatment 1)

Choice set 1			Identification number: ………	
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION "NONE"**
Drink:	Light Coke	Classic Coke	Water	None
Sandwich:	Vegetarian	Hamburger	Omelet	of
Price:	4,75€	3,35€	4,30€	them
	☐	☐	☐	☐
Please mark the option you would choose.				

Experimental design

Figure5: An example of a choice set presented in NH-RRCA (Treatment 1)

Choice set 1				Identification number: ………
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION "NONE"**
Drink:	Light Coke	Classic Coke	Water	None
Sandwich:	Vegetarian	Hamburger	Omelet	of
Price:	4,75€	3,35€	4,30€	them
	1ª 2ª 3ª ☐ ☐ ☐	1ª 2ª 3ª ☐ ☐ ☐	1ª 2ª 3ª ☐ ☐ ☐	☐

Please Rank the option 1, 2 and 3 from the most preferred to the least preferred **or** mark the option None.

Experimental design

Figure 6: An example of a choice set presented in NH-CBCA (Treatment 2)

Choice set 1			Identification number: ……….	
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**
Drink:	Light Coke	Classic Coke	Water	Juice
Sandwich:	Vegetarian	Hamburger	Omelet	Frankfurter
Price:	4,75€	3,35€	4,30€	3,80€
	☐	☐	☐	☐
	OPTION 5	**OPTION 6**	**OPTION 7**	**OPTION "NONE"**
Drink:	Light Coke	Classic Coke	Water	None
Sandwich:	Frankfurter	Omelet	Vegetarian	of
Price:	4,30€	4,75€	3,80€	them
	☐	☐	☐	☐
Please mark the option you would choose.				

Experimental design

Figure7: An example of a choice set presented in NH-RRCA (Treatment 2)

| Choice set 1 | Identification number: .... |

Experimental design

Figure 8: The choice set presented in the holdout task (Treatment 1& 2)

Experimental design

- Participants were also asked to complete a brief questionnaire on their demographic and socioeconomic characteristics.

- After completing the questionnaire, one of the two tasks was randomly drawn to be the binding task.

  - If the main task is the binding task, one of the 16 choice sets was then randomly drawn to be the binding choice set. In the NH-CBCA (NH-RRCA) format, each participant obtains the option she/he has chosen (ranked first) in the binding choice set and pays the price indicated in that option.

  - If the binding task is the holdout task, then each participant buys his/her chosen option and pays the price indicated in that option.

  - If the chosen option is the no-choice option, then the participant does not buy any combo product and does not pay any money.

Experimental design

- Participants who ended up purchasing a combo product were given two coupons, representing the specific sandwich and drink chosen during the experiment, which they could then redeem at the university restaurant after the experiment (during the next month).

Experimental design

- In total, eight independent variables were considered:

  - Three effect-coded variables from the sandwich attribute (i.e., **Hamburger**, **Frankfurter**, and **Omelet** (setting the level "Vegetarian" as the reference level)). In effects coding, the utility of the reference level is defined as the negative sum of the estimated utilities of the levels considered in the estimation.

  - Three effect-coded variables from the drink attribute (i.e., **Classic Coke**, **Light Coke**, and **Juice** (setting the level "Water" as the reference level)).

  - The variable "**Price**", linear; and

  - The "**No choice**" dummy-coded variable.

Data analysis and Model estimation

- The Hierarchical Bayesian Multinomial Logit Model (Allenby et al., 1998).

- Comparison between CBCA and the RRCA was carried out based on:

  - *The estimated partworths*: as we have estimated individual partworths, we used a two-tailed t-test to assess if consumers' preferences in both CA formats are driven by similar or different factors.

Data analysis and Model estimation

- *Hit rates* to assess the internal and external validity of the estimates. Hit rates are calculated by comparing the choice predicted by the model for an individual respondent, using the maximum utility rule, to the actual choice made by the respondent.

- *Internal validity*, we used the estimated partworths to predict the respondent's choices in the main task., We then compared the predicted choice to the actual choice in the main task to calculate the hit rate.

- *External validity*, the estimated partworths in the main task are used to predict the respondent's choices in the hold out task. Then the predicted and the actual choices in the holdout task are compared to determine the hit rate.

Data analysis and Model estimation

- Estimated **willingness to pay** (WTP): the average WTP is calculated by dividing the estimated partworth associated with the attribute's level by the estimated partworth of the price attribute with a negative sign.

- A **two-tailed t-test** was used to assess whether consumers' WTP in both CA formats are statistically different.

- For robustness check, we also used the **complete combinatorial test** proposed by Poe et al. (2005). The bootstrapping method by Krinsky and Robb (1986) was used to generate 1000 WTP values for each CA format (R and SAS).

Results

Table 3: Hierarchical Bayesian Multinomial Logit estimates

Attribute		Treatment 1		Treatment 2	
		NH-CBCA	NH-RRCA	NH-CBCA	NH-RRCA
Drink	Juice	-1.758**	-1.699***	0.057	-2.239***
		(1.739)	(1.390)	(1.150)	(1.299)
	Light Coke	-1.711**	0.492	-0.977***	-1.232***
		(1.800)	(1.138)	(1.493)	(1.115)
	Classic Coke	**2.559***	**2.188***	**2.716***	**2.531***
		(1.399)	(1.075)	(1.255)	(1.059)
	Water	0.910*	-0.981*	-1.797***	0.939***
		(1.499)	(1.418)	(1.530)	(1.021)
Sandwich	Omelet	0.391	-1.081**	-1.712***	-0.074
		(1.484)	(1.399)	(1.603)	(1.435)
	Frankfurter	-0.537	0.414	-0.489**	0.682**
		(1.597)	(1.170)	(1.484)	(1.551)
	Hamburger	**1.859***	**1.440***	**2.064***	**3.506***
		(1.707)	(1.141)	(1.444)	(1.215)
	Vegetarian	-1.714**	-0.773	0.137	-4.115***
		(1.795)	(1.674)	(1.543)	(2.413)
Price	**Price**	**-7.947***	**-6.339***	**-9.517***	**-7.159***
		(2.139)	(1.582)	(2.334)	(1.576)
None option	None	6.994***	5.055***	11.731***	0.558
		(1.973)	(1.483)	(2.570)	(4.361)
Percent Certainty		0.792	0.783	0.813	0.786
Root Likelihood		0.778	0.758	0.708	0.672
Number of observations		688	688	736	736

*** (**) (*) Statistically significant at 1%, 5% and 10% level. The statistical tests for Hierarchical Bayesian consist in looking at the distribution of draws (after assuming convergence, last ten thousand draws) and to count how many of the draws differ from zero with the same sign. If 95%+ of the draws are all in agreement, either all above or below zero, then this is viewed as strong evidence that the parameter differs from zero.

Results

Table 4: Equivalence/Divergence between NH-CBCA and NH-RRCA in terms of estimated partworths

Parameters	Treatment 1			Treatment 2		
	NH-CBCA	NH-RRCA	P-Value	NH-CBCA	NH-RRCA	P-Value
Juice	-1.758	-1.699	0.95	0.058	-2.239	**0.00**
Light Coke	-1.711	0.492	**0.01**	-0.977	-1.232	0.69
Classic Coke	2.559	2.188	0.63	2.717	2.532	0.81
Water	0.910	-0.981	**0.02**	-1.797	0.940	**0.00**
Omelet	0.391	-1.081	0.10	-1.712	-0.075	**0.02**
Frankfurter	-0.537	0.414	0.21	-0.490	0.683	0.17
Hamburger	1.859	1.440	0.65	2.065	3.507	**0.04**
Vegetarian	-1.714	-0.773	0.40	0.137	-4.115	**0.00**
Price	-7.947	-6.339	0.14	-9.517	-7.159	**0.03**
None	6.994	5.055	0.12	11.731	0.558	**0.00**
Root Likelihood	0.778	0.758	0.59	0.708	0.672	0.40

Results

Table 5: Results from the internal and external validity analysis

Treatment	Mechanism	Internal validity (in sample = main task)				External Validity (out sample = holdout task)			
		Total number of choices	Number of correct predictions	%	p-value	Total number of choices	Number of correct predictions	%	p-value
Treatment 1	NH-CBCA	688	608	88		43	22	51	
					0.29				0.66
	NH-RRCA	688	595	87		43	20	47	
Treatment 2	NH-CBCA	736	602	82		46	38	83	
					0.09				0.09
	NH-RRCA	736	576	78		46	31	67	

Results

Table 6: Estimated willingness to pay values (€) for each level of attribute

	Attribute	Level	NH-CBCA	NH-RRCA	T-test (p-value)	Complete combinatorial test (p-value)
Treatment 1	Drink	Juice	-0.22	-0.27	0.93	0.47
		Light Coke	-0.22	0.08	0.03	0.34
		Classic Coke	0.32	0.35	0.84	0.47
	Sandwich	Omelet	0.05	-0.17	0.59	0.37
		Frankfurt	-0.07	0.07	0.12	0.47
		Hamburger	0.23	0.23	0.82	0.37
Treatment 2	Drink	Juice	0.01	-0.31	0.63	0.28
		Light Coke	-0.10	-0.17	0.46	0.45
		Classic Coke	0.29	0.35	0.94	0.45
	Sandwich	Omelet	-0.18	-0.01	0.60	0.37
		Frankfurt	-0.05	0.10	0.09	0.45
		Hamburger	0.22	0.49	0.69	0.37

Concluding Remarks

- In a <u>small</u> choice set setting, our results generally suggest that responses in terms of preferences are <u>similar</u> across NH-CBCA and NH-RRCA.

- However, when respondents are provided with <u>large</u> choice sets, a <u>divergence</u> between NH-CBCA and NH-RRCA emerges in terms of estimated partworths and predictive power.

- Nevertheless, we found that the estimated WTPs are statistically similar across the NH-CBCA and the NH-RRCA and in both small and large choice set settings.

Concluding Remarks

- In Overall, our results imply that within a small choice set context, one could more confidently use either CA format when eliciting preferences or estimating WTP values for private or public goods

- More care must be taken in choosing a CA format in larger choice set settings. Notwithstanding time and budget constraints, it might be prudent for example to use both types of CA format to test the robustness of findings given the divergence in results we found in our larger choice set setting.

- A Limitation of this study is the non consideration of an increasingly popular CA format: **Best Worst Scaling**

THANK YOU