Examining consumer preferences on environmental policies designed for sustainable airline industry

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Abstract

The airline industry is expanding rapidly due to rising demand for air travel. With increasing emissions to the environment this growth threatens the sustainability of the industry. Various environmental policies can be implemented, some of which require consumer participation. Knowledge about consumer preferences towards these policies is therefore necessary. In this paper, consumer preferences towards four environmental policies are revealed through a discrete choice experiment. A context effect is also included in the experiment, to create different social norms and analyse how these affect respondents' preferences. The results show that consumers' utility drops most strongly when the maximum allowed luggage weight is reduced. The airline efficiency is the second most important factor in utility. Voluntary carbon offsetting does not affect consumer utility in the sample as a whole, but the results indicate that when many people offset their carbon emission, the respondents derive a positive utility from offsetting and when few offset their carbon emission then respondents derive a negative utility (disutility) from offsetting. These results support the idea that social norms affect consumer preferences and should be taken into considerations when implementing environmental policies.

Keywords

Choice experiment, Context effect, Consumer preferences, Environmental policies, Airline industry

1 Introduction: Overview on aviation pollution problem

Nowadays, air travel has become a means of transport for more than two billion passengers a year (Macintosh & Wallace, 2009). As a result, passenger travel is accountable for the largest part of total emissions caused by aviation (Gössling et al., 2009). Passengers fly for their vacations or work and some even commute on regular basis. However, they rarely reflect on the consequence of these air travels on the climate (Hares et al., 2010). This holds true even with highly educated passengers who generally have environmentally friendly attitude in life (Lassen, 2010).

The increasing demand[1] for air travel has confronted the airline industry with a dilemma. On one hand, the airline industry wants to grow rapidly; on the other hand the industry's predominant reliance on fossil fuels has turned it to one of the fastest growing polluters in respect with other modes of transport. Up to 6.8% annual growth rate in CO_2 emissions has been reported by GösslingLaw & Peeters (2007). This trend threatens the sustainability of the airline industry.

Technology has succeeded in reducing aircraft emissions by 40% in engine improvements and 20% in reduced air resistance of the fuselage (Greene, 1992; Lee et al., 2009). However, the growth of airline industry has outpaced all these efforts to reduce emissions and hence the overall emission have increased over the past decades (Åkerman, 2005; Peeters et al., 2009).

Further reduction in aviation emissions requires effective environmental policy measures. These policies can (and are) implemented on different domains such as airline operations, aircraft maintenance procedures and on passengers who are the consumers of airline industry.

In this study, we focus on four airline environmental policies which have potential emission reduction capacities. These policies require air traveller participation. These four policies are: 1) voluntary carbon offsetting by passengers, 2) optimising free luggage allowance, 3) considering environmental efficiency of airlines and 4)demanding airlines contribution towards carbon offsetting projects.

In order to assess the effectiveness of these policies, we need to gather some insight on passenger preferences towards them. This is done by estimating utility obtained by respondents while choosing among different attributes of policies in a discrete choice based experiment.

The policies are embedded into different attributes of alternative airlines. While respondents chose among different airlines in the choice sets, they implicitly, revealed their preferences among these policies.

To the best of our knowledge, there has not been a study combining several environmental policies in a single discrete choice experiment to estimate the level of consumer complacency from each one of the policies.

As well as finding peoples' preferences regarding environmental policies, we have also introduced a context effects in our choice experiment. This combination of choice experiment and context effects scenario testing is done to observe how people make their

[1] Kroesen (2012) refers to the reports published by the two major aircraft manufacturers, Airbus and Boeing(2010) which announced 6% in average annual growth rate for air travel over past 50 years.

choices while influenced by their surrounding social norms and conditions as suggested by Buckley et al. (2011).

There are three context items which are added to the choice experiment. In the first context we told our respondents that 8 to 10% of airline passengers are contributing to the carbon offsetting projects (base case), in the second context we increased this figure to 50% of passengers and in the third context we raised this number once more to 80 to 85% of passengers.

Stern (2000) and Mair (2011) propose that people's behaviour is affected by the social context. We attempt to see if these context effects do have a significant influence on the choices made on policies and if plausible findings can be derived from the combinations of these two elements (discrete choice and context effect) in an empirical study.

In this paper, we briefly review the selected environmental policies (section 2). Then we introduce the methods of collecting consumer preferences on the selected policies and how the context effect has been incorporated in the choice experiment (section 3). Finally we present the results and discuss the findings of our analysis (section 4).

2 Airline environmental policies

We have studied four airline environmental policies which require direct consumer participations. By the phrase consumer participation, it is implied that passenger can choose to adopt the policy or not. Next, a brief overview of the four policies are given.

2.1 Voluntary Carbon-offsetting by consumers

Voluntary Carbon Offsetting (VCO) schemes are probably the most studied airline environmental policy at consumer level. By implementing VCO policy, airlines allow passengers to offset the carbon emissions caused by their travels at their own free will. The offsetting costs are calculated by multiplying the CO_2 emitted during the particular flight by a (fixed) price for a ton of CO_2 emissions. If the passengers decide to pay these costs, then they have off-setted their personal CO_2 emitted due to that flight (Hofer et al., 2010).

For this policy, we selected three prices based on an average of realistic figures obtained from airlines for the given flight journey. Our respondents were asked to choose between fully offsetting carbon emissions by paying €20 extra over their ticket price or partially offset carbon emissions by paying €10 or do not offset at all (€0).

Regarding the VCO policy, there are disagreements among practitioners and academics over the emission calculation methods and offsetting prices. On top of that there are various accreditation programs/organisations which verify the use of revenues in assigned emission reduction projects. The presence of these different stakeholders adds to the complexity involved with VCO projects and has great impact on the effectiveness and credibility of the VCO schemes (Gössling et al., 2007). Consequently, this has created confusion and sometimes hostility in consumers to contribute towards the offsetting project (Gössling et al., 2009).

2.2 Optimizing free luggage allowance

Most freight carried by airline industry is in the form of passenger luggage. Lee et al. (2009) suggests that by optimizing the freight carried for passenger as in form of luggage in passenger aircraft, would present further opportunities in increasing the efficiency of traffic and hence reduction in emissions.

Luggage optimization policy aims to influence passengers to carry less luggage onboard aircraft by providing incentives for them. Discounts on airfare ticket can be offered to passengers per kilogram of weight voluntarily reduced by them. These discounts mentioned can be provided based on savings achieved when burning less fuel for flying lighter aircraft.

In this policy, the limit to carry luggages varied between different optional airlines and they were as following: 10Kg, 15kg and 20Kg per passenger. These weight ranges are the prevalent amounts practised by airlines for each passenger at current situation.

2.3 Application of airline environmental efficiency index

It has been suggested that there is an urgent need to provide consumers with an accurate energy consumption or an environmental impact information of the goods and services offered by suppliers. This will probably stimulate energy rational and environmentally sustainable behaviour of consumers (Mansouri et al., 1996).

In the case of airline industry, if environmental efficiency of airlines are determined and introduced to the consumers in transparent manner then consumers can integrate this information in their selection of airline to travel (Gössling et al., 2009). Therefore implementing an environmental efficiency labelling system for the airline industry seems to be a policy option.

Up until now some attempts have been made to create a standard airline efficiency labelling system. Atmosfair Airline Index[2] is a recognised labelling system which ranks airlines according to their climate efficiency based on CO_2 emitted per payload kilometre.

This policy was displayed to our respondents in form of an eco-efficiency labelling index. The environmental efficiency of each airline varied between A-label (highly efficient) to C-label (poorly efficient).

2.4 Airline-Passenger joint collaboration for carbon offsetting

The core of this policy evolves over VCO schemes with different approach from stakeholders. According to this policy, airlines become active alongside passengers to participate in offsetting project. Airlines contribute some or equal amount that each passenger is paying towards an offsetting project.

This kind of collaboration can be an example of co-creation of environmental value between airlines and passengers as suggested by Gössling et al. (2009). It may also offer competitive advantage for airlines by acquiring environmental credibility (Mayer et al., 2012).

[2]By atmosfair gGmbH

In this policy our respondents were able to choose the 100% figure which would imply that they preferred the airline to pay equal amount that each passenger has paid for a VCO scheme. If the 50% figure was selected then it would mean that the airline should pay at least half the price of each passenger's VCO contribution. When the 0% figure was selected then the airline contributed nothing while the passengers paid for the VCO schemes (which resembles current situation).

With this policy, passengers may be further motivated to contribute towards the offsetting projects since their contributions have additional consequent of engaging airline's own participation. On the other hand, this policy would also allow airlines to offset some of their emissions in preparation to the upcoming European Union Emissions Trading Scheme (EU ETS).

Next, we explain how the above mentioned polices were put together to form a choice based experiment and also the context effect that was added to the choice experiment.

3 Methodology

Discrete choice experiment or otherwise known as stated choice (SC) is used to test the policies in the empirical part. Stated choice is frequently applied in transport literature to estimate passenger preferences on certain elements under study.

Three context effect were also integrated with the choice experiment to test the changes in choice behaviour of respondents under the influence of different social norms. We developed the choice experiments the three context effect scenarios.

3.1 The choice experiment

In the choice experiment, the respondents were told to consider taking a return flight between London (UK) to New York (USA)which would cost between €505 to €545[3].

This route was chosen for two reasons, firstly many airlines operate this route and it is possible to compare ticket prices and carbon offsetting prices across different carriers from different nations. Secondly it would allow us to compare our results with finding of a similar experiment conducted by MacKerron et al. (2009).

In this experiment, the environmental policies were introduced as attributes of this imaginary flight journey with varying levels. Figure 1 demonstrates the transformation of policies into attribute and levels that were used in the choice experiment.

By arranging different combination of attributes-levels in the choice sets, we tried to deliver several conformation of the environmental policies. While respondents choose among optional airlines that offered different combinations of policies, they implicitly revealed their preferences on these policies.

Bliemer et al. (2009) recall the work of some researchers which have used efficient designs (instead of traditional orthogonal designs) to arrange attributes and levels in choice sets. With these efficient designs smaller standard errors are achieved and this would increase the reliability of parameters estimated by the choice experiment.

[3]Ticket prices were taken from real airlines prices operating at this route at the time of conducting the survey.

Environmental policy	Corresponding attribute in choice experiment	Attribute levels
Voluntary carbon offsetting by consumers	Passenger contribution for CO_2 offsetting in €	€ 0 , € 10 , € 20
Optimizing free luggage allowance	Luggage limit in Kg	10 kg, 15 kg , 20 kg
Application of airline environmental efficiency index	Eco-efficiency of the airline	A, B, C
Airline-Passenger joint collaboration for carbon offsetting	Amount of airline contribution over passenger CO_2 compensation	0% , 50% , 100%

Figure 1: Transforming environmental policies into attributes for choice experiment.

Following these recent trends in SC literature, efficient design was applied for the construction of our choice experiment with the help of Ngene software[4].

To develop an efficient design, some preliminary parameter estimated values were required. These initial values can guide the experimental designer to arrange attribute-levels in such manner that results to smallest standard errors possible. These initial values were taken from an earlier pilot study performed by Araghi (2012) with a smaller sample size .

We asked each respondent to study eight choice sets and this was done to keep the length of the survey in tolerable time length. Respondents selected their preferred airline from each choice set and also answered some other related social-economic questions.

Three types of questionnaires, each contain eight choice sets, were developed. The questionnaires were arranged in three blocks and one context effect element was implemented in each block. The composition of choice sets throughout all blocks were arranged in such way to keep a balance of attribute-levels in them.

Figure 2 shows an example choice set listed in block 3 in our choice experiment. The respondents were asked to choose between one of these optional airlines as they feel most suitable with their preferences. For every alternative, there is a ticket price and four other attributes (which represent the four policies mentioned in figure 1).

3.2 Addition of context effects to the choice experiment

A unique context effect was added to each block in the choice experiment. Since each respondent was presented with only one block, therefore each respondent would receive a single context effect.

Blocks were distributed evenly[5] among respondents so that equal number of participants receive one of the three blocks. With this method we tried to create different context effects for equal number of respondents.

Figure 3 shows how different context effects were assigned to blocks. For instance in block 2, we told our respondents to imagine that on average 50% of airline passengers contribute towards carbon offsetting while taking a flight. We were interested in how choice behaviour of respondents would compare with other blocks.

[4]Provided by ChoiceMetrics Pty Ltd

[5]This was automatically performed by the on-line application.

Example Choice Set	Option 1	Option 2	Option 3
Ticket price €	**€ 545**	**€ 525**	**€ 505**
Passenger contribution for CO_2 offsetting in €	**€ 20** (full compensation)	**€ 20** (full compensation)	**€ 10** (partial compensation)
Luggage limit in Kg	**15 kg**	**20 kg**	**10 kg**
Eco-efficiency of the airline	**C**	**C**	**B**
Amount of airline contribution over passenger CO_2 compensation	**0%**	**100%**	**50%**
Your Choice	○	○	○

Figure 2: An example choice set, given to respondents in block 3

Block Number	The context Effect
1	On average 8% to 10% of airline passengers participate in carbon offsetting schemes (base case)
2	On average 50% of airline passengers participate in carbon offsetting schemes (imaginary)
3	On average 80% to 85% of airline passengers participate in carbon offsetting schemes (imaginary)

Figure 3: Context effect and corresponding block numbers

Context Effect	Indicator 1	Indicator 2
8-10% passenger contribution	1	0
50% passenger contribution	0	1
80-85% passenger contribution	-1	-1

Table 1: Context effect converted under the effect coding

3.3 Estimating respondent preferences on policies

The data from choice experiment were presented to the BIOGEME[6] software. The software was used to estimate the coefficients of different attributes based on Multi-Nomial Logit (MNL) models. The values of these coefficients indicate the utility derived by respondents regarding the policies.

The selection of MNL model was based on the assumptions that the total utility obtained by respondents is composed of a systematic non-random part and the random error part. The systematic, non-random part of utility is derived from the choices of alternatives made by respondents in each choice sets. The other assumption was that the additional random error term would be independently and identically distributed (IID) (Hensher et al., 2005). With these assumptions, the MNL model was applied for the choice experiment data.

The MNL model was performed at two stages to achieve two purposes. At first stage the MNL model was performed on the whole of the sample to generally evaluate the preferences of respondents towards the environmental policies. At the second stage, a specific model was performed for each of the three blocks. this was done to estimate the differences in preferences of respondents towards the policies when the context was varied between them.

3.4 Testing the significance of the context effect variables

To determine the significance of different MNL models derived from the three blocks (i.e. estimate the diversities in passenger preferences), interaction parameters between the context effect and the main attributes were calculated. Hensher et al. (2005) describe interaction parameters as the impact of a treatment (which are the context effects in here) on the response variable which are the choices in the SC experiment.

As suggested by Molin et al. (2009) the three context effect variables were represented by effect coding as seen in table 1. With the effect coding two indicator variables are developed. These two variables are multiplied by the five main attributes which then result in 10 interaction parameters.

We use the Likelihood-ratio test (Gourieroux et al., 1982) to examine whether the model fit has been improved after these 10 new interaction parameters have been added to the original MNL model.

[6]BIerlaire Optimization toolbox for GEv Model Estimation (BIOGEME) developed by Michel Bierlaire, Ecole at Polytechnique Federale de Lausanne, Transport and Mobility Laboratory, CH-1015 Lausanne, Switzerland. Email: michel.bierlaire@ep.ch

4 Results

The participants of the experiment were mainly students of Delft University of Technology and their relatives and acquaintances. Our sample, therefore, mainly represents young Dutch adults with higher education with average age of 26 years. Although this sample may not be a representative of the whole population but it can be an indicator of preferences of young and educated consumers in Dutch society whom most probably be the frequent users of the airlines services in the near future. Therefore their preferences over the four proposed policies can offer some insight on the effectiveness of these policies.

The respondents were approached by means of a web-page. During one week of data collection (7th to 14th of June 2012) a total of 419 individuals completed the survey entirely which represents 61.3% response rate. Male respondents were 56% and their female counterparts composed 44% of the sample.

During the year prior the survey, our respondents spent on average 32 days in another location other than their home town for vacation and on average they had 1.53 return flights within the same time period.

4.1 Estimating general preferences on policies

An initial model was developed for main attributes which can also be called the main effect model. Equation 1 shows the utility function and the estimated coefficient from this MNL model.

$$U_i = -0.0404X_{1i} - 0.0029X_{2i} + 0.116X_{3i} - 0.265X_{4i} + 0.0033X_{5i} \qquad (1)$$

Where X_{ji} is the variable in which levels of corresponding attribute can alter. First indices for X_{ji} refers to the attribute which changes from 1 to 5 (see table in figure 1) and the second indices of X refers to alternative airline offered in choice set which changes from option 1 to option 3. For instance X_{23} means that this variable is related to the second attribute (i.e. VCO policy) of the third alternative airline (option 3). U_i refers to the utility derived from each alternative airline offered in choice sets.

The sign of the coefficients in above equation indicate whether the utility of respondents is raised or reduced by increasing the value of attribute-level. For instance the coefficient of X_{2i} in equation 1 is negative but then the coefficient of X_{3i} is positive. The interpretation of this sign is that the respondents loose utility by contributing in VCO schemes but in the same time they gain utility by carrying more luggage.

After calculating the coefficients, we can replace the X_{ji} in each equation with the levels of attributes and draw part worth utility graphs of each attribute.

In figure 4, the utility for each attribute has been drawn against the attribute levels. The graphs in figure 4 show how part worth utility for a given attribute (or otherwise known as environmental policy) varies with linear parameter data.

A general overview of the graphs of figure 4 indicate an increase in respondents' utility for carrying more luggage. Similarly for joint airline-consumer offsetting policy, we observe increasing utility generated for respondents when airline contributes more towards VCO schemes.

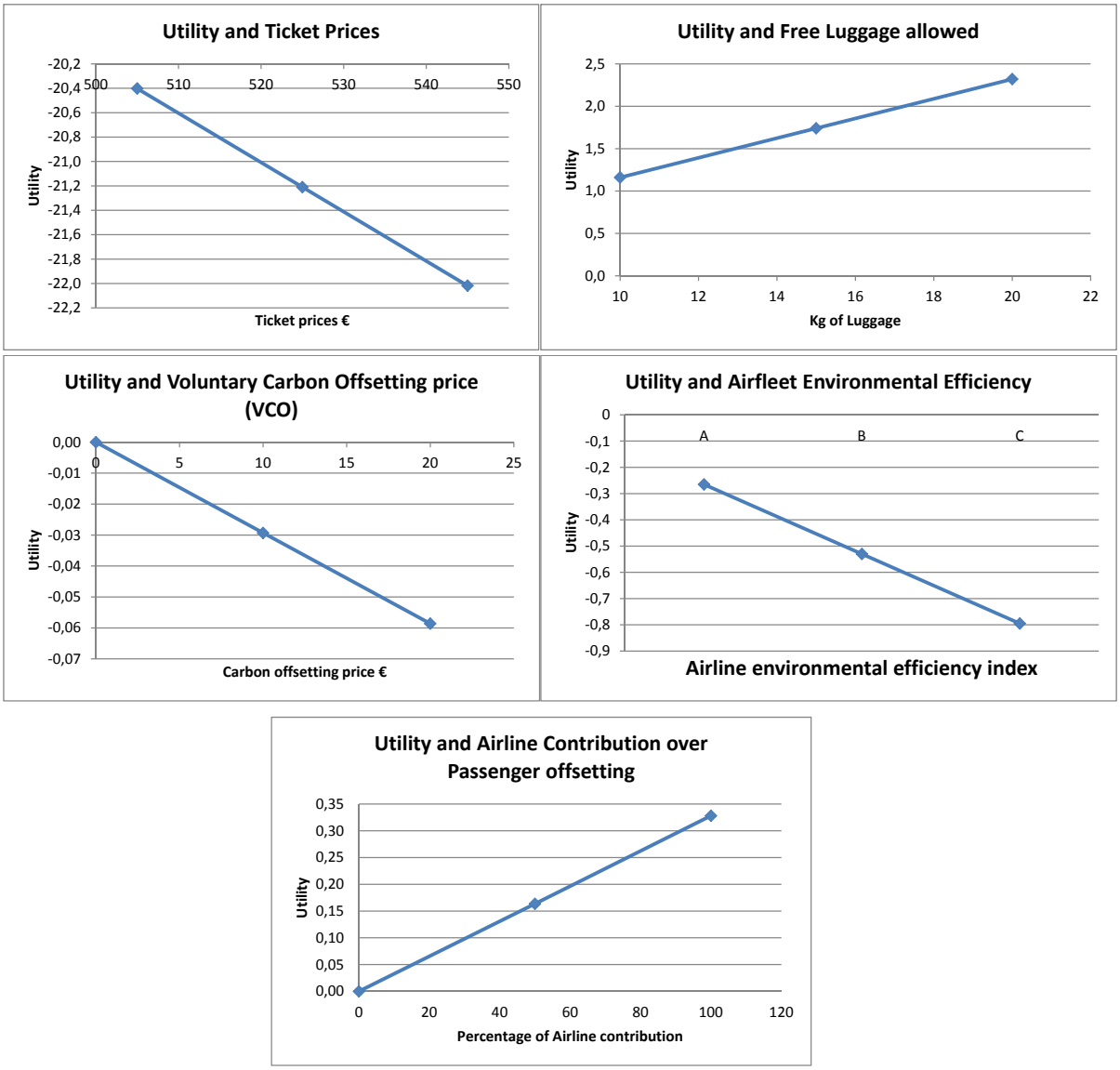

Figure 4: Part worth utility obtained by respondents from the four airline environmental policies and the ticket price

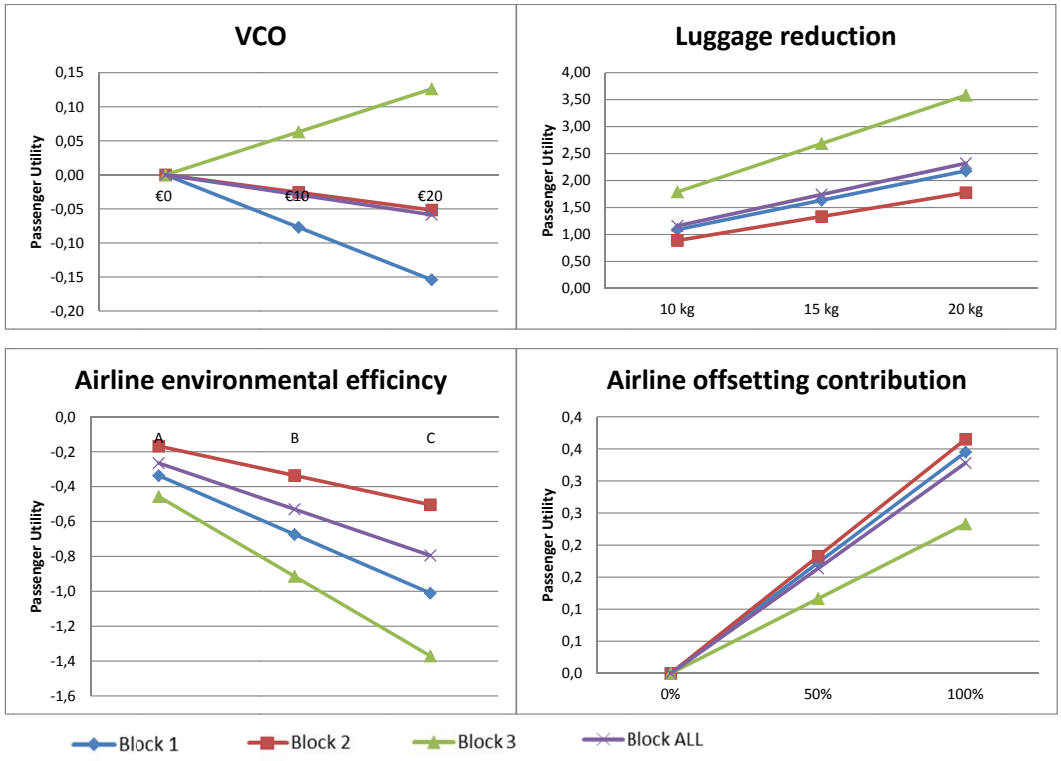

Figure 5: Comparing the utility obtained by respondents under influence from different context effect scenarios

Furthermore, the utility of the respondents in figure 4 dropped when the environmental efficiency index of the airlines reduced from A to C. The other decreases in utility are visible as the ticket price increases as well as passenger contribution payment for VCO schemes. These results are generally in agreement with our own intuition prior the empirical study.

4.2 Context effect testing and policy implications

As mentioned before, some social norm issues were embedded in form of context effect and each were assigned to a specific group of respondents in form of blocks. When analysing respondents' choices in each block, we observed that the context effect experiment, has indeed caused some impact on the stated preferences of the respondents.

Most notable differences in preferences of respondents in different blocks occurred on the VCO policy, luggage carrying policy and also Airline efficiency policy. This can be seen in figure 5, where part worth utility of respondents in each block have been drawn separately for every policy attribute.

By using the BIOGEME software and applying MNL models, we calculated the interaction coefficients of the context effect and the main attributes. Table 2 shows the t-ratio for the coefficients calculated. Those coefficients with t-ratio higher than 1.96 or lower than -1.96 are statistically significant based the 95% confidence interval.

From table 2 it can be seen that interaction of "indicator 2 & luggage reduction" policy and "indicator 2 & Airline environmental efficiency" are found to be significant. The interpretation of these significant interaction is that the difference between utili-

Interaction effect	Coefficient value	t-ratio
Indicator 1 * Ticket	-0.0029	1.04
Indicator 1 * VCO	-0.0064	-1.58
Indicator 1 * Luggage reduction	-0.0166	-1.69
Indicator 1 * Airline environmental efficiency	-0.0163	-0.28
Indicator 1 * Airline offsetting contribution	0.0003	0.39
Indicator 2 * Ticket	0.0040	1.46
Indicator 2 * VCO	-0.0013	-0.34
Indicator 2 * Luggage reduction	-0.0367	-3.56
Indicator 2 * Airline environmental efficiency	0.153	2.54
Indicator 2 * Airline offsetting contribution	0.0005	0.65

Table 2: Testing significance of diversities of utilities among different context effect scenarios

ties obtained by respondents of block 2 and block 3 in luggage reduction policy and Airline environmental efficiency policy are considerable. This can be seen in figure 5 between the red line (block 2) and the green line (block 3) on the graph drawn for the two mentioned policies.

One possible explanation for high utility gain by respondents in block 3 for carrying more luggage can be given. Since this group of respondents assumed a lot of passengers are already offsetting their carbon emission through VCO policy, then the sense of feeling guilty for carrying more luggage is reduced. Whereas this sense of "feeling guilty" is not seen in other two respondent groups.

We also notice sharp diversities on the utilities obtained by respondents in block 1 (blue line) and block 3 (green line) on VCO policy[7].

Regarding the policy implications of context effect testing and VCO policy, we can at least claim that by varying the social norms condition, we observed a total conversion in stated preference of respondents about the VCO schemes. The proof can be given by the fact that respondents in block 1, lost utility (negative utility) by contributing towards the VCO policy to compare with respondents from block 3 who gained utility (positive utility) by contributing towards VCO schemes.

These insights from VCO policy and context effect outcomes are in accordance with Brouwer et al. (2008), where they suggest that passengers are willing to contribute more to VCO schemes "if and only if" increasing number of passengers also participate and the number of free riders are reduced.

The airline environmental efficiency policy also displays sharps differences in utility gains or losses of respondents in different context groups. Respondents in block 3, who became more environmental concious due to the impact of context effect experiment, lost substantial amount of utility. This means that the context effect experiment not only had direct effect on the VCO policy, it also had a substantial effect on the environmental efficiency policy. Whereas the utility loss of the respondent in block 1 and 2, who assumed less environmental consciousness among passengers, was not as much as respondents in block 3.

[7]Despite this visible sharp differences on the graph, it was not statistically significant. Nevertheless, with t-ratio of -1.58 it was close to the boundary of -1.96 significance level).

5 Conclusion

Implementing successful policies in any domain requires a prior estimates from the state of mind of the stakeholders who would confront that policy. The underlying purpose of the choice experiment in this study was to generate these estimates for four selected policies in pollution mitigation area in civil aviation.

Moreover, this study showed how satisfaction/dissatisfaction of people towards different airline environmental policies changes when they are placed in different contextual situations.

When people are put in different context scenarios in similar experiments, their stated preferences and choices varied widely on one policy but not so much on another policy. For instance the preferences of respondents in different context groups did not differ widely with respect to the airline own contribution to offsetting schemes policy. Whereas, the same context effect scenarios created a wide contrast in preferences of respondents with respect to the VCO policy or airline environmental efficiency policy.

Practitioners and airline strategists can benefit from the insights provided by this study regarding consumer preferences on the proposed policies. These perception may assist policy maker in designing adapted and successful policies for the future course of the airline industry and guide it towards more sustainable practice.

For the social sciences domain, it might be interesting to consider that "social norms" can create considerable changes on the behaviour of the consumers and produce more desired outcomes for environmental purposes. This is also in line with the "moral responsibility" concept suggested by Nyborg et al. (2006) while consumers are considering to adopt to greener alternatives in their daily lives.

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