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Evidence of passenger preferences for specific types of airports

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Abstract
Studies of air travel choice behaviour increasingly make use of data collected through stated choice surveys. Here, we put forward the hypothesis that when making their choices in such surveys, respondents may complement the information presented to them by additional attributes. Specifically, we look at characteristics linked to airport size and breadth of service, as well as the proximity to a respondent's home. Our findings in a discrete choice analysis suggest that, all else being equal, respondents prefer larger to smaller airports while having a preference for the airport closest to their home. This could suggest that even though respondents associate a higher likelihood of delay and other inconveniences with larger airports, there is a perception that if things go wrong (e.g. flight cancellations); the backup options at larger airports (e.g. replacement aircraft) being superior to those at small or regional ones.

Keywords: airport choice; discrete choice; random utility; regional airports; travel behaviour

1. Introduction

An increasing number of studies of air travel choice behaviour make use of stated choice (SC) data, where previous studies had generally relied on the use of revealed preference (RP) data. While posing certain issues in terms of response quality (Louviere et al., 2000), studies using SC data have the advantage of being based on accurate records of all information presented to respondents, which is not generally the case with RP data. As such, it should come as no surprise that SC studies are generally more successful in retrieving significant effects for crucial factors such as airfares and frequent flier benefits.

As mentioned above, a major advantage of SC data is that the analyst has exact information on all attributes presented to the respondent. This is crucial in relating choice behaviour to the characteristics of the different alternatives faced in a choice task. There remains, however, a possibility that the respondent's choices are also influenced by factors not presented during the SC experiment. In the analysis presented in this paper, we aim to explore this issue further in the context of a SC experiment looking at the combined choice of airport and airline for a domestic trip in the United States. Specifically, we hypothesise that respondents in this survey do not limit their perception of an alternative to the attributes presented to them in the survey, but complement this list with other perceived attributes of the different options. In the present analysis, we limit this to attributes of the different airports, but this could easily be extended to attributes of specific airlines and the approach is also applicable outside an air travel context.

2. Data and preliminary analysis

The data used come from an Internet survey conducted at regular intervals by Resource Systems Group Inc. looking at domestic air travel in the US. The analysis makes use of the 2002 version of the data, although the age of the sample should not adversely affect the applicability of our approach[2].

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[2] .Further details on the data are given by Resource Systems Group Inc. (2003), with previous applications using the data being discussed in Adler et al. (2005), Hess et al. (2007) and Hess (2008).

The first stage of the survey collected data on the most recent domestic air trip by a respondent, along with socio-demographic information, including information on membership in frequent flier programmes. On the basis of the observed trip, a number of alternative flight options, in terms of airports and airlines, were compiled, and the respondents were asked to rank them in order of preference. For the airline options, the ranking was performed under the assumption of equal fares, while the ranking of airports was performed independently of the differences in access time.

The SC survey uses a binomial choice set, with ten choice situations per individual. In each choice situation, the respondent is faced with a choice between the current observed trip and an alternative journey option, compiled on the basis of the information collected in the first part of the survey. Aside from the actual airline and airport names, the attributes used to describe the two alternatives in the SC survey include flight time, the number of connections, the airfare, the arrival time (used to calculate schedule delays), the aircraft type, and the on-time performance of the various flights.

The final sample contains data collected from 617 respondents; with 10 choice situations per respondent, giving 6,170 observations split into 1,190 from business travellers, 1,840 from holiday travellers and the remainder from other travellers, dominated by those visiting friends and family (VFR). Further segmentations, for example by employment status, did not provide additional insights.

The purpose of the work is to identify potential effects of attributes that respondents associate with the alternatives without these attributes having been included in the SC presentation. We limit ourselves to airport specific factors, and the various attributes added to the data in this context are:

- annual passenger numbers at the different airports in the study year,
- identification of an airport as a large hub[3],
- identification of an airport as a main airport[4],
- identification of an airport as a function of its name, dividing airports into international airports, regional airports, municipal airports and airports without a specific tag, and
- identification of an airport as the airport closest to a passenger's home.

For each passenger, four airports are used based on the preliminary rounds of the survey. Before proceeding to the choice modelling analysis, we look at how the passengers' ranking of their airports relates to the various attributes listed. The results are summarised in

[3] This status was assigned to those 33 airports that accounted for at least one percent of annual passenger numbers in the US.
[4] This status was assigned to 11 airports with the highest name recognition, including for example JFK and LAX.

Table 1 for the overall sample, Table 2 for business travellers, Table 3 for holiday travellers, and

Table 4 for VFR and other travellers.

For passenger numbers, the average number of passengers is shown for the airports included in the respondent-specific sets, along with the share of traffic across the four airports. The remaining attributes are airport specific, and in some cases, none of the airports used in a respondent's set of airports exhibits these any of these. The tables show a rate of inclusion, giving the percentage of respondents for which at least one of their four airports has the specific attribute applying to it. This is then complemented by the average rate, across the resulting subset of respondents, for each of the airports in terms of applicability of the different attributes. For some respondents and attributes, more than one of the airports exhibits a specific attribute, hence the four columns do not necessarily add up to 100%[5].

Looking at the four tables, we can make the following observations:

- in terms of passenger numbers, and the share of traffic, busier airports are ranked lower across all three purpose groups,
- airports with the main airport tag are included in the sets for less than half of all respondents, and the tag is most likely to apply to the lowest ranked airport,
- airports with the large hub tag are included for around 80% of respondents, and the tag is most likely to apply to the lowest ranked airport,
- airports with the international tag are included for over 90% of respondents, and the tag is most likely to apply to the lowest ranked airport,
- airports with the regional and municipal tags are included in the sets for around 40% of respondents, and the tag is more likely to apply to the higher ranked airports, and
- the airport closest to a respondent's home is included in the set of four airports for all respondents, and the closest airport is likely to be ranked higher. Here, there is some evidence of a less extreme preference for the closest airport for business travellers.

Overall, this preliminary analysis suggests respondents have a strong dislike for larger and busier airports; the respondents would still be more likely to choose these options given the higher capacity and breadth of service, but in a SC context that compares two flights directly, it should be possible to separately identify any such underlying preferences for specific types of airports.

3. Model specification

A large number of variables were included in the initial specification search. Aside from the continuous variables such as flight fare, flight time, access time, percent on-time performance, and early and late schedule-delay (SDE and SDL), a number of discrete variables were also included. Three dummy variables take account for the effects of frequent flier (FF) programme membership, where these were associated with standard membership, silver membership, and gold membership. Similarly, dummy variables were included for flights with a single or double connection, while dichotomous variables were also associated with the different types of aircraft included[6]. Finally, an alternative specific constant (ASC) was included for the base alternative.

For characteristics specific to different airports, various specifications were attempted. In terms of airport size, we experimented with overall passenger numbers, the share of traffic among the four airports in the respondent-specific set, and the share of traffic among the two airports used in a specific choice set. The use of the share of traffic among the airports in the respondent-specific set

[5] This even applies for the closest airport category as a few respondents have more than one airport that is at the same distance from their home.

[6] Standard jet was used as the base, leading to the estimation of additional terms for turbo props, regional jets and widebody jets.

produced the best results. Constants were associated with main airports, large hubs, international airports, regional airports, municipal airports[7] and airports closest to a respondent's home.

With the purpose of the present analysis being to offer a first investigation of the issues set out in Section 1, we limit ourselves to linear in parameters Multinomial Logit (MNL) models[8]. All models were estimated using BIOGEME[9] (Bierlaire, 2003).

4. Results

Base models

The estimation results for the base models are summarised in Table 5, with willingness-to-pay (WTP) measures presented in Table 6. In the initial estimation, no differences could be retrieved between the sensitivities to early and late arrival, leading to the use of a joint coefficient for schedule delay, β_{SD}.

In the cross-purpose model, all estimates obtain high level of statistical significance. The main coefficients are all of the expected sign, and in addition, we find that respondents have a preference for widebody jets over standard jets, where the latter are preferred to regional jets and turbo props. For business travellers, the coefficients for higher levels of FF benefits are only significant at the 92% level for $\beta_{FF\ silver}$ and the 87% level for $\beta_{FF\ gold}$, while the sensitivity to double connections is only significant at the 90% level and is no different from the sensitivity to single connections. Furthermore, there is no difference between preferences for standard and widebody jets. To some extent, these lower levels of significance can be seen as a result of the smaller sample size. For holiday travellers, the coefficients for higher levels of FF benefits are only significant at the 74% level for $\beta_{FF\ silver}$ and the 91% level for $\beta_{FF\ gold}$, while the only aircraft type effect that could be identified was for widebody jets. Finally, for VFR and others, no effect could be identified for $\beta_{FF\ gold}$, while the effects for $\beta_{FF\ standard}$ and $\beta_{FF\ silver}$ are only significant at the 75% and 81% level respectively.

Looking at WTP implications in Table 6, we see the expected evidence of much lower fare sensitivity for business travellers. Overall, access time sensitivity is lower than flight time sensitivity, while schedule delay sensitivity is surprisingly low. The WTP for reductions from a double connection is higher than that for single connections, where the ratio is almost exactly 2:1 in the cross-purpose sample, while it is much higher in the holiday models and much lower in the business models. We also note high WTP for FF benefits, especially for business travellers, in line with past findings (Hess et al. 2007). Finally, other than in the holiday segment, travellers have a strong dislike for turbo props and regional jets, with holiday travellers and VFR & others having a preference for widebody over standard jets.

Models accommodating airport type information

The estimation results for the models incorporating airport-specific information not included in the presentation of SC scenarios are summarised in Table 7, with willingness-to-pay (WTP) measures presented in Table 8.

Looking first at model fit, we obtain an increase in log-likelihood by 23 units for the cross-purpose model when compared to the base model in Table 5. Coming at the cost of 3 additional parameters, this is a highly significant improvement, with a χ^2_3 test value of 46 compared to the 99% critical value

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[7] The base here being airports without a specific *tag*.

[8] No consideration was given to the repeated choice nature of the data, and this should be kept in mind when looking at the significance of the estimates.

[9] See also biogeme.epfl.ch

of 11.35. The improvements for the three purpose-specific models are similarly all significant above the 99% level of confidence.

Across the four models, no effects could be identified for *large hubs*, *international airports* and *regional airports*. However, for all four models, there is a significant positive estimate for $\beta_{\text{share of traffic}}$. For $\delta_{\text{main airports}}$, we obtain a positive estimate for business travellers, significant at the 92% level, along with a negative estimate for holiday travellers. For $\delta_{\text{municipal airports}}$, there is a significant negative effect in the cross-purpose model as well as in the models for holiday travellers and VFR & other, while, for $\delta_{\text{closest airport}}$, we obtain positive estimates in the cross-purpose model, significant at the 94% level, and in the model for holiday travellers, significant at the 85% level.

In terms of WTP implications (Table 8), there are only small differences for the main indicators when compared to the base model in Table 6. Additionally however, we see that all passengers are willing to pay a small bonus for flying from an airport with a larger market share, while holiday travellers are also willing to pay a surplus of $14 for flying from the airport closest to their home. While business travellers are willing to pay $72.52[10] extra to fly from one of the 11 main airports, holiday travellers require a reduction in fare by $27 to do so. Finally, with the exception of business travellers, all respondents have a dislike of municipal airports, where the willingness to pay $76 extra to avoid such an airport is significant at the 90% level for holiday travellers, with a 84% level for the corresponding figure of $32 for VFR & other travellers.

5. Conclusions

Studies of air travel choice behaviour increasingly make use of data collected through stated choice surveys. Such studies have the advantage of having at their disposal accurate information on all attributes that respondents were faced with while completing the survey. This can be a considerable advantage over studies making use of revealed preference data.

In this paper, we have put forward the hypothesis that when making their choices, respondents may in fact complement the information presented to them by additional attributes. Specifically, we have looked at the scenario where respondents make a choice between different airports and where we have made the case that some of the respondents may be influenced in their choice by attributes specific to the airport that were not included in the survey presentation. Specifically, we have looked at characteristics linked to airport size and breadth of service, as well as the proximity to a respondent's home.

Initial questioning in the survey seemed to suggest that, all else being equal, respondents have a dislike of larger airports, where this is potentially a reflection of perceived stress of using such airports as well as the higher risk of delay. On the other hand, there seems to be a trend by respondents to rate the airport closest to their home higher.

We retrieve any effects of airport size and proximity within the context of a choice modelling analysis. Here, the results contradict those from direct questioning by suggesting that after taking into account any flight specific attributes, including on-time performance respondents have a preference for larger airports. The findings in terms of a preference for the airport closest to a respondent's home are consistent with those from the direct questioning of respondents.

Within the context of the stated choice experiment, respondents were asked to select one of two flights put forward to them, described on the basis of various attributes of these flights. The findings suggest that while respondents make their choices on the basis of these attributes, they also take

[10] Significant at the 91% level

into account factors not presented to them. While on the basis of the direct questioning there seems to be a general dislike of larger airports, all else being equal, respondents are still more likely to choose options from such airports, potentially due to a perceived sense of higher levels of service. As such, while they might expect more congestion at these airports compared to smaller ones, they also potentially seem to feel that backup options at such airports in case of flight cancellation, overbooking, and the like, are superior to those at smaller airports.

Our findings are limited to a single dataset and the analysis should be repeated on other samples. Additionally, the set of attributes could be expanded to include characteristics specific to different airlines[11]. Nevertheless, the findings suggest that respondents make their choices not solely on the basis of attributes presented to them but expand this set of explanatory variables when comparing the different options they are faced with.

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[11] This is of increasing interest given growing product differentiation.

Table 1: Preliminary data analysis: cross-purpose

		Airport ranking			
	Inclusion rate	Highest	2nd	3rd	Lowest
Av. passenger numbers	-	3,318,825	3,239,561	3,849,061	11,083,298
Av. share of traffic	-	13.08%	13.58%	17.45%	55.89%
Main airport	46.02%	14.08%	19.37%	14.44%	54.93%
Large hubs	79.42%	30.82%	24.49%	24.90%	74.90%
International	93.52%	29.98%	45.41%	47.66%	85.62%
Regional	36.63%	45.13%	44.25%	30.97%	3.98%
Municipal	13.45%	45.78%	31.33%	30.12%	2.41%
Regional/municipal	43.76%	51.85%	46.67%	35.19%	4.07%
Closest airport	100.00%	66.45%	15.56%	9.08%	19.94%

Table 2: Preliminary data analysis: business travellers

		Airport ranking			
	Inclusion rate	Highest	2nd	3rd	Lowest
Av. passenger numbers	-	3,662,477	3,382,373	2,936,094	11,130,153
Av. share of traffic	-	13.77%	14.93%	13.63%	57.66%
Main airport	43.70%	15.38%	19.23%	11.54%	59.62%
Large hubs	79.83%	36.84%	27.37%	16.84%	77.89%
International	92.44%	33.64%	40.00%	43.64%	86.36%
Regional	36.13%	53.49%	48.84%	20.93%	0.00%
Municipal	13.45%	43.75%	25.00%	37.50%	0.00%
Regional/municipal	42.02%	60.00%	50.00%	30.00%	0.00%
Closest airport	84.03%	52.00%	50.00%	56.00%	24.00%

Table 3: Preliminary data analysis: holiday travellers

		Airport ranking			
	Inclusion rate	Highest	2nd	3rd	Lowest
Av. passenger numbers	-	3,402,824	2,818,425	4,449,971	11,147,679
Av. share of traffic	-	12.74%	11.53%	20.20%	55.53%
Main airport	49.46%	13.19%	18.68%	16.48%	53.85%
Large hubs	82.07%	29.14%	21.19%	30.46%	74.17%
International	95.65%	25.57%	40.91%	49.43%	86.36%
Regional	39.67%	46.58%	46.58%	26.03%	2.74%
Municipal	13.59%	32.00%	36.00%	32.00%	8.00%
Regional/municipal	45.11%	50.60%	51.81%	32.53%	4.82%
Closest airport	100.00%	78.67%	28.00%	8.67%	21.33%

Table 4: Preliminary data analysis: VFR and other travellers

	Inclusion rate	Airport ranking Highest	2nd	3rd	Lowest
Av. passenger numbers	-	3,139,365	3,432,218	3,842,933	11,027,815
Av. share of traffic	-	13.02%	14.26%	17.28%	55.43%
Main airport	44.90%	14.18%	19.86%	14.18%	53.90%
Large hubs	77.71%	29.51%	25.41%	24.59%	74.18%
International	92.68%	31.27%	50.17%	48.11%	84.88%
Regional	35.03%	40.91%	40.91%	38.18%	6.36%
Municipal	13.38%	54.76%	30.95%	26.19%	0.00%
Regional/municipal	43.63%	49.64%	42.34%	38.69%	5.11%
Closest airport	100.00%	81.08%	15.44%	12.74%	26.64%

Table 5: Estimation results for base models

	Cross-purpose		Business		Holiday		VFR & other	
Respondents	617		119		184		314	
Observations	6,170		1,190		1,840		3,140	
Final LL:	-2,238.94		-481.95		-612.54		-1,014.10	
Parameters:	14		13		12		13	
adj. ρ^2	0.473		0.4		0.51		0.528	
	est.	signif.‡	est.	signif.‡	est.	signif.‡	est.	signif.‡
δ_1	0.5110	***	0.3220	***	0.7370	***	0.6530	***
β_{fare}	-0.0124	***	-0.0056	***	-0.0157	***	-0.0180	***
$\beta_{flight\ time}$	-0.0080	***	-0.0077	***	-0.0082	***	-0.0089	***
$\beta_{access\ time}$	-0.0070	***	-0.0059	***	-0.0059	***	-0.0087	***
$\beta_{on\text{-}time\ performance}$	0.0092	***	0.0056	**	0.0111	***	0.0113	***
β_{SD}	-0.0010	***	-0.0012	**	-0.0010	**	-0.0011	***
$\delta_{FF\ standard}$	0.2700	***	0.6110	***	0.3940	**	0.1480	
$\delta_{FF\ silver}$	0.5210	**	0.6970	*	0.6040		0.5540	
$\delta_{FF\ gold}$	1.1800	*	1.2600		1.6700	*	-	-
$\delta_{1\ connection}$	-0.3070	***	-0.4560	***	-0.2880	**	-0.2660	***
$\delta_{2\ connections}$	-0.6090	***	-0.5080	*	-1.0100	***	-0.4390	**
$\delta_{turbo\ prop}$	-0.5590	***	-0.8800	***	-	-	-0.5320	***
$\delta_{regional\ jet}$	-0.3010	***	-0.6980	***	-	-	-0.2370	**
$\delta_{widebody\ jet}$	0.4340	***	-	-	0.4500	***	0.7210	***

‡ *** = 99% level; **=95% level; *=90% level

Table 6: Willingness-to-pay results for base models

	Cross-purpose		Business		Holiday		VFR & other	
	est.	signif.‡	est.	signif.‡	est.	signif.‡	est.	signif.‡
flight time reductions ($/hr)	38.61	***	82.02	***	31.41	***	29.73	***
access time reductions ($/hr)	34.06	***	63.19	***	22.43	***	29.13	***
schedule delay reductions ($/hr)	4.65	***	12.66	**	3.71	**	3.73	***
one connection to direct ($)	24.76	***	80.85	***	18.34	**	14.78	***
two connections to direct ($)	49.11	***	90.07		64.33	***	24.39	**
improved on-time performance ($/10%)	7.45	***	9.89	**	7.07	***	6.28	***
flying on airline with standard FF ($)	21.77	***	108.33	***	25.10	**	8.22	
flying on airline with silver FF ($)	42.02	**	123.58	*	38.47		30.78	
flying on airline with gold FF ($)	95.16	*	223.40		106.37	*	-	-
flying on turbo prop *vs* standard jet	-45.08	***	-156.03	***	-	-	-29.56	***
flying on regional jet *vs* standard jet	-24.27	***	-123.76	***	-	-	-13.17	**
flying on widebody jet *vs* standard jet	35.00	***	-	-	28.66	***	40.06	***

‡ *** = 99% level; **=95% level; *=90% level

Table 7: Estimation results for models with airport type information

	Cross-purpose		Business		Holiday		VFR & other	
Respondents	617		119		184		314	
Observations	6,170		1,190		1,840		3,140	
Final LL:	-2,215.93		-475.34		-603.83		-1,001.85	
Parameters:	17		15		16		15	
adj. ρ^2	0.478		0.406		0.514		0.533	
	est.	signif.‡	est.	signif.‡	est.	signif.‡	est.	signif.‡
δ_1	0.4110	***	0.2670	**	0.6250	***	0.5520	***
β_{fare}	-0.0125	***	-0.0058	***	-0.0158	***	-0.0181	***
$\beta_{flight\ time}$	-0.0079	***	-0.0079	***	-0.0083	***	-0.0089	***
$\beta_{access\ time}$	-0.0056	***	-0.0051	***	-0.0035	**	-0.0082	***
$\beta_{on\text{-}time\ performance}$	0.0096	***	0.0058	***	0.0122	***	0.0119	***
β_{SD}	-0.0010	***	-0.0013	**	-0.0010	*	-0.0011	***
$\delta_{FF\ standard}$	0.2600	***	0.6220	***	0.3920	**	0.1120	
$\delta_{FF\ silver}$	0.5600	**	0.6470		0.6140		0.6200	
$\delta_{FF\ gold}$	1.1800	**	1.1900		1.6300	*	-	-
$\delta_{1\ connection}$	-0.3000	***	-0.4610	***	-0.2880	**	-0.2540	**
$\delta_{2\ connections}$	-0.6060	***	-0.4490		-1.0500	***	-0.4140	**
$\delta_{turbo\ prop}$	-0.5470	***	-0.8380	***	-	-	-0.5140	***
$\delta_{regional\ jet}$	-0.3100	***	-0.7120	***	-	-	-0.2490	**
$\delta_{widebody\ jet}$	0.4160	***	-	-	0.4360	***	0.7260	***
$\beta_{share\ of\ traffic}$	0.4410	***	0.4190	**	0.5070	**	0.5680	***
$\delta_{main\ airports}$	-	-	0.4170	*	-0.4270	**	-	-
$\delta_{large\ hubs}$	-	-	-	-	-	-	-	-
$\delta_{international\ airports}$	-	-	-	-	-	-	-	-
$\delta_{regional\ airports}$	-	-	-	-	-	-	-	-

$\delta_{municipal\ airports}$	-0.6880	**	-	-	-1.2000	*	-0.5810	
$\delta_{closest\ airport}$	0.1500	*	-	-	0.2250		-	-

‡ *** = 99% level; **=95% level; *=90% level

Table 8: Willingness-to-pay results for models with airport type information

	Cross-purpose		Business		Holiday		VFR & other	
	est.	signif.‡	est.	signif.‡	est.	signif.‡	est.	signif.‡
flight time reductions ($/hr)	37.92	***	82.23	***	31.44	***	29.40	***
access time reductions ($/hr)	26.64	***	52.90	***	13.29	**	27.22	***
schedule delay reductions ($/hr)	4.74	***	13.25	**	3.87	*	3.68	***
one connection to direct ($)	24.00	***	80.17	***	18.23	**	14.03	**
two connections to direct ($)	48.48	***	78.09		66.46	***	22.87	**
improved on-time performance ($/10%)	7.64	***	10.09	**	7.72	***	6.57	***
flying on airline with standard FF ($)	20.80	***	108.17	***	24.81	**	6.19	
flying on airline with silver FF ($)	44.80	**	112.52		38.86		34.25	
flying on airline with gold FF ($)	94.40	**	206.96		103.16	*	-	-
flying on turbo prop *vs* standard jet	-43.76	***	-145.74	***	-	-	-28.40	***
flying on regional jet *vs* standard jet	-24.80	***	-123.83	***	-	-	-13.76	**
flying on widebody jet *vs* standard jet	33.28	***	-	-	27.59	***	40.11	***
flying from an airport with bigger share of traffic ($/10%)	3.53	***	7.29	**	3.21	**	3.14	***
flying from a *main* airport	-	-	72.52	*	-27.03	**	-	-
flying from a *municipal* airport	-55.04	**	-	-	-75.95		-32.10	
flying from the *closest* airport	12.00	*	-	-	14.24		-	-

‡ *** = 99% level; **=95% level; *=90% level