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Modeling Service Trade-Offs in Air Itinerary Choices

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The application of a mixed logit approach using stated-preference survey data to the development of itinerary choice models is described. The models include the effects on itinerary choices of airline, airport, aircraft type, fare, access time, flight time, scheduled arrival time, and on-time performance. The empirical results demonstrate the importance of explicitly accounting for traveler preference heterogeneities by using segmentation by trip purpose, interaction effects involving frequent flier status, and random parameter specifications. Explicitly including preference heterogeneity by using the mixed logit specification results in significant statistical improvements and important coefficient differences as compared with using a standard fixed-parameter logit model. The calculated marginal rates of substitution show the relative importance that travelers assign to key service variations among itineraries. All service features that were included in the model had significant values to travelers, and the values were affected, as would be expected, by the traveler's frequent flier status. Although current reservation and ticketing services provide information to prospective travelers on most of these itinerary features, most services do not report on-time performance, which, however, can be an important selection criterion for travelers.

The U.S. domestic air travel market has changed in many ways over the past several years. One important change has been an increase in the range of options available to travelers in many markets. Low-fare airlines provide options with trade-offs that in many cases involve use of more-remote airports, more-circuitous routings, and additional transfers. However, some of the low-fare carriers, such as Southwest Airlines, have chosen those more-remote airports in part to avoid the congestion in primary airports and thus increase their on-time performance. These additional options create a rich mix of choices for travelers in many markets.

Since 2000, the authors have conducted an annual survey of U.S. domestic air travelers. The survey covers travelers' perceptions of reservation and ticketing services, airports, airlines, and equipment. It includes an adaptive conjoint exercise addressing in-flight amenities such as seating, food, and entertainment and a set of stated-preference experiments dealing with choices among alternative air travel itineraries. A set of itinerary choice models is described here that were developed by using these survey data.

APPROACH

Several previous research efforts have modeled the choice among alternative travel itineraries by using aggregate itinerary share data. One of the most recent of these, undertaken by researchers at United Airlines and Northwestern University (*1*), compares multinomial logit and several forms of generalized extreme value models that are structured by time of departure, airline, and class of service. Because of the limitations of aggregate itinerary share data, the independent variables are limited to general characterizations of level of service (number of connections), connection quality, overall airline fare ratios, aircraft type, and time of day. Although these variables are useful for general airline service planning, they do not provide information about all of the basic behavioral trade-offs that air travelers make when choosing among alternative itineraries. In addition, the aggregate data do not include characteristics of the individual travelers or of the trip purposes that likely affect the itinerary choices.

Other studies have used survey data taken from individual travelers to estimate trade-offs among itinerary service elements. One such study used a set of stated-preference experiments for a hypothetical trip to estimate the effects of fare, carrier, fare class restrictions, flight timing, frequent flier status, and other variables on itinerary choices (*2*). A Swedish study used both revealed-preference (actual flight choices) and stated-preference data for a hypothetical trip (price, service level, departure time, and booking restrictions) to estimate service trade-offs (*3*).

The research described in this paper also uses revealed- and stated-preference survey data from individual travelers but differs in two important respects from past studies. First, the stated-preference experiments were customized for each traveler by using heuristics programmed into the survey software so that they represented realistic alternatives for one of the respondent's recent trips. Each of the stated-preference exercises asked respondents to select among the actual travel itinerary and two such constructed alternatives. The survey asked respondents to consider the actual circumstances of the trip that was made in choosing among the alternatives, and thus the responses reflect situation-dependent preferences and constraints. The second important difference from previous studies is that the analyses of the survey data included explicit modeling of heterogeneity among individual travelers, not just among aggregate traveler segments. Random parameter (mixed) logit was used to estimate the coefficients of itinerary choice models. This approach removes potential bias from the estimates of average service trade-off levels and provides additional insight into the degree of variation that exists in key service preferences across the traveler population.

The survey that collected the revealed-preference data and stated-preference exercises is an annual Internet-based U.S. domestic air travel survey that is conducted by the authors. The survey is administered to a sample of approximately 600 individuals who have made paid domestic air trips within the past year. The survey questionnaire collects detailed information on the most recent of these trips, including the trip purpose, desired arrival time, reservation and ticketing service, airports used for the trip, airline, aircraft type, and details of the chosen itinerary. In addition to information about the choices that were made, respondents are asked to indicate levels of satisfaction with, and preferences among, alternative ticketing, airport, and airline alternatives. Two types of stated-preference exercises are included; one covers basic service elements that are assumed to directly affect itinerary choices and the second covers in-flight amenities. A database of locations of all airports with scheduled commercial service is used to identify possible airport alternatives for the flight, and respondents are asked to indicate which among those they would consider. Finally, the questionnaire collects detailed information about the traveler including basic demographic information, air travel frequency, and membership levels in frequent flier programs. Details of the survey design and overall findings from the study are contained in the annual project report (*4*).

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The stated-preference experiments are constructed by using the recent past trip as a base alternative, and a synthesized "realistic" alternative is developed by using information about the base trip. The following attributes are included in the stated-preference exercises and varied using a fractional factorial experimental design.

- Airline. Alternative airlines are chosen for inclusion from among a set that respondents rank (assuming equal price) in advance of the stated-preference exercises. The respondent sees only the airline name in the scenario descriptions, but both the actual airline and its initial preference rank are included in the resulting data set. In these exercises, the airline company serves as a proxy for service quality elements.
- Airport. As with airlines, airports are chosen for inclusion from among a set that are identified both from the airport database as reasonable and from self-identified other airports. Respondents rank these airports (not considering access time) in advance of the stated-preference exercises. The respondent sees only the airport name in the scenario descriptions, but both the actual airport and its initial preference rank are included in the resulting data set. In these exercises, the airport serves as a proxy for airport service quality elements beyond access time.
- Access and egress times. Access and egress times for the given airports are computed on the basis of airport locations and respondent-supplied trip end locations and are presented for each scenario.
- Flight times. The total departure-to-arrival-gate times (including connection times) are computed and varied in ways to ensure that the presented times are realistic for the given itinerary.
- Connections. Nonstop and one- and two-connection alternatives are selectively created as appropriate to each airport pair.
- Fares. Fares are varied around the level that the respondent paid for the chosen flight.
- Schedule time difference. Respondents identify their desired arrival time, and a time representing the difference between that time and the itinerary's arrival time is presented.
- Aircraft type. Aircraft are identified by four general categories: propeller/propjet, regional jet (100 seats or fewer), standard jet (single aisle), and wide-body (two aisles).
- On-time performance. On-time performance levels varying from 50% to 99% are assigned to the stated-preference alternative; for the chosen flight, the respondent indicates whether it was on time.

These attributes represent the set of information that is available to travelers when they compare itineraries either through a travel agent or (more commonly) online and as such represent a reasonable set of variables to use in modeling individual itinerary choices. Most online reservation services show all of these items with the exception of on-time performance; some online sites have provided on-time performance estimates but most currently do not, even though those data are available. Although fare class should arguably be included as either a choice attribute or choice dimension, in fact the majority of domestic first-class itineraries are currently flown as free or low-cost upgrades to frequent fliers and many airlines and routes do not provide two-class service.

In addition to service variables, it is likely that individual characteristics and trip context significantly affect itinerary choices. An obvious, measurable context variable is trip purpose; business travelers are likely less sensitive to fares and more sensitive to travel times than are nonbusiness travelers. Travelers' incomes, travel frequencies, and frequent flier membership likely have similar effects. In addition, across travelers and even for a given traveler across different trip contexts, there is likely considerable variation in sensitivities to itinerary attributes due to less easily measured context differences. As for many other choice situations, these variations are likely important, and failure to consider them could result in biased estimates of the attribute effects.

For this study, a mixed logit model form was used to identify and account for variations in individual and context preferences across the sample. Mixed logit models relax the assumption that all individuals in a given segment have identical preferences, which is assumed in other forms such as the widely used multinomial logit model. Each coefficient in a mixed logit model can be specified as fixed (assumed constant across the segment) or randomly varying with a given distribution. The distribution can be specified as, for example, uniform, triangular, normal, or lognormal, and simulation methods are used to estimate parameters of the distributions (e.g., the mean and standard deviation for a normal distribution or the mean and range for a uniform distribution). Mixed logit models have been used for a wide range of choice contexts and have important advantages in this type of application [see, for example, the paper by Hensher and Greene (*5*)]. For this application as with many other similar applications, identification of both systematic differences in preferences and levels of heterogeneity among consumers is useful in modeling the choice process. In addition, it is important to explicitly account for correlations among the stated-preference experiments.

SURVEY SAMPLE

As noted earlier, the survey sample consists of approximately 600 individuals who had made a paid U.S. domestic air trip within the past year. The 600 completed surveys were derived from an initial sample of approximately 1,000 randomly selected qualified travelers. Respondents were compensated for completing the 30- to 45-min online interview.

Traveler and Trip Characteristics

The survey sample consists of individuals with a median household income of $75,000 whose median air travel frequency is approximately monthly. Just over 10% of the sample are mid- or top-level elite members of at least one frequent flier program, in which membership was reported for each airline in five categories: not a member, basic member, first-level elite (typically 25,000 mi/year), second-level elite (typically 50,000 mi/year), and top-level elite (typically 100,000+ mi/year). Respondents were asked to describe their most recent qualifying air trip. For over 80%, this was a trip made within the most recent 6 months. About 43% of the trips were for business and the remaining 57% were split among vacation (19%), visiting friends and relatives (35%), and other purposes (3%). The median travel time to the originating airport was about 45 min, but 11% reported traveling more than 2 h to the airport. The median amount of time spent waiting at the airport before the flight was between 1 and 1½ h. These times are almost identical to the averages from the authors' pre-9/11 surveys, indicating that additional security is not significantly affecting wait times (*6*). The median travel time between originating and destination airports was about 3½ h. More than 30% of the reported air trips had at least one connection or stop. Only 10% of the itineraries had significant flight delays.

Reservations and Ticketing

There have been dramatic shifts in the ways in which travelers obtain flight information and make reservations, which potentially affect the amount and type of information that travelers have available and use in making their itinerary choices. Reductions in travel agent commissions have resulted in agencies' charging for many reservations and ticketing services. At the same time, Internet-based services, both airline-based and independent, have improved and expanded to offer many travel services that were previously available only through agents. The survey includes several questions dealing with reservations and ticketing.

Choice of Ticketing Locations

Although the survey sample is dominated by those who have Internet access, only 60% reported acquiring their most recent ticket from an online source, as shown in Figure 1. This percentage, however, is a significant increase from the 33% reported in the authors' 2000 survey and the 40% in 2001 and represents an acceleration of the trend that began in the late 1990s. Most of the increase from 2001 to 2002 has been on airlines' websites and virtually all comes at the expense of travel agent ticketing and telephone or in-person purchases from the airlines. Of the tickets purchased through travel agencies, almost 60% are from local agents and another 20% are from local agencies that are affiliated with a national agency. Among the web-based sites, the share of tickets bought through Orbitz increased significantly at the expense of Travelocity and numerous other smaller sites.

The profiles of travelers using each of the ticketing options vary somewhat. Travel agents and other purchase locations (predominantly corporate travel offices) are used more often by business travelers, who are reimbursed for their travel. However, the most frequent

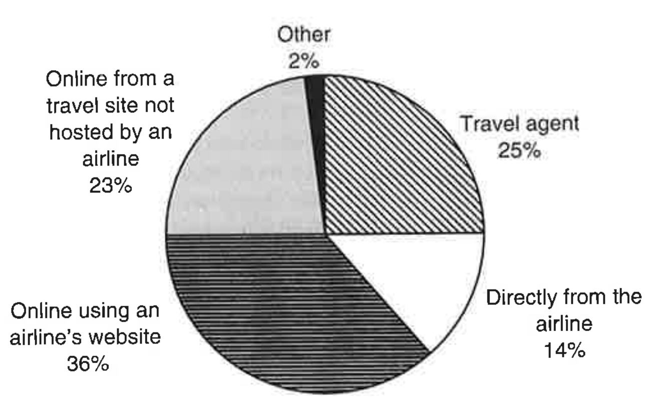

FIGURE 1 Ticket purchase location.

travelers are more likely to use airlines' websites for ticketing, presumably benefiting from the frequent flier bonuses that are commonly available at the airline sites. Those who purchase directly from the airlines (over the phone or at ticket counters) are a somewhat more mixed group, including travelers who fly infrequently and those who pay personally for their travel. Airline and independent websites attract a disproportionate fraction of frequent fliers who are at elite levels of one or more programs.

MODEL ESTIMATION

Fixed and random parameter (mixed) logit models were estimated with the stated-preference data from the survey sample. Several econometric software packages currently support simulation-based estimation of these models; for this work, the LIMDEP NLOGIT package was used. All models were adapted to account for correlation across the stated-preference experiments for each individual, reflecting the fact that the responses to multiple experiments from a single respondent are likely not independent. The initial models were estimated by using both Halton sequences and less-efficient pseudo-random draws, with no systematic differences observed, and so Halton sequences were used for the remainder of the model estimation work (*7*). Posterior estimates of person-specific utility functions were also calculated to examine the distribution of values across the sample.

Because of the large statistically significant differences in coefficient values between business and nonbusiness travelers, the sample was segmented into those two trip purposes. Within each trip purpose, a variety of random parameter specifications and demographic interaction effects were tested. Normal distributions were used for the random parameters for three reasons: (*a*) they generally resulted in improved log-likelihood values over other distributions, (*b*) the simulated distributions did not result in significant incidences of reversed signs for a priori positive or negative coefficients across the population, and (*c*) problems were experienced in the estimation of lognormal distributions for the nonnegative parameters of properly transformed variables. (Variables for which nonpositive coefficients were expected were multiplied by −1, as is required for applying the lognormal distribution to those coefficients.) Problems with estimating parameters of lognormal distributions have been noted by other researchers (*8*). Although random heterogeneity of some degree was observed in most of the parameter estimations, the random parameters were included in the final models only for those variables whose standard deviations were consistently statistically significant across model specifications.

Interactions of mean parameter values were tested with several demographic variables, and the most significant of these effects resulted from an elite frequent flier membership variable defined as those having mid- or top-level membership in the designated airline's frequent flier program. Tables 1 and 2 detail the estimation results from a multinomial logit specification that assumes no heterogeneity, and Tables 3 and 4 show results with heterogeneity modeled using mixed logit.

In Tables 1 and 2, the coefficients and *T*-ratios are shown for all tested service variables. In the business segment model without heterogeneity (Table 1), all core service attribute coefficients have intuitively reasonable signs and magnitudes. The utility coefficients of the jet aircraft types are greater than the value for propeller planes but not statistically different at the 95% level. Similarly, the value of the third-ranked airport is not statistically different from that of the lowest-ranked airport. For the nonbusiness model without hetero-

TABLE 1 Estimation Results: Business Travel Logit Model

Service Variables	Coefficient	*T*-Stat
Constant (actual itinerary)	0.242	2.0
Propeller	0	N/A
Regional jet	0.340	1.8
Standard jet	0.176	0.9
Wide-body	0.347	1.4
Airline ranked first	0.734	4.8
Airline ranked second	0.458	2.7
Airline ranked third	0.471	2.6
Airline ranked lowest	0	N/A
Airport ranked first	1.23	5.8
Airport ranked second	0.503	2.3
Airport ranked third	−0.243	−0.9
Airport ranked lowest	0	N/A
One-way fare ($)	−0.00556	−10.9
Flight time (min)	−0.00883	−7.1
Access–egress time (min)	−0.00575	−4.5
On-time performance (%)	0.00806	3.7
# of connections	−0.368	−3.0
Schedule time difference (min)	−0.00200	−2.3

N/A = not applicable.

TABLE 2 Estimation Results: Nonbusiness Travel Logit Model

Service Variables	Coefficient	*T*-Stat
Constant (actual itinerary)	0.117	1.5
Propeller	0	N/A
Regional jet	0.276	2.3
Standard jet	0.512	4.3
Wide-body	0.972	6.4
Airline ranked first	0.578	6.7
Airline ranked second	0.265	2.8
Airline ranked third	0.278	2.6
Airline ranked lowest	0	N/A
Airport ranked first	1.17	9.8
Airport ranked second	0.738	5.9
Airport ranked third	0.454	3.3
Airport ranked lowest	0	N/A
One-way fare ($)	−0.0125	−22.7
Flight time (min)	−0.00734	−11.0
Access–egress time (min)	−0.00422	−5.7
On-time performance (%)	0.00709	5.3
# of connections	−0.303	−4.8
Schedule time difference (min)	−0.00126	−3.5

N/A = not applicable.

TABLE 3 Estimation Results: Business Travel Mixed Logit Model

Service Variables	Type	Coefficient	*T*-Stat	Standard Deviation	*T*-Stat	Elite Flyer Interaction	*T*-Stat
Constant (actual itinerary)	Fixed	−0.4163	−4.5				
Propeller	Base	0	N/A				
Regional jet	Fixed	0.5078	3.9				
Standard jet	Fixed	0.4077	3.0				
Wide-body	Fixed	0.5808	3.6				
Airline ranked first	Normal	0.9817	8.8	0.4786	4.3	1.9136	4.6
Airline ranked second	Fixed	0.8833	7.2				
Airline ranked third	Fixed	0.6636	5.2				
Airline ranked lowest	Base	0	N/A				
Airport ranked first	Normal	0.9817	8.8	0.6783	6.4	0.2510	0.5
Airport ranked second	Fixed	0.9434	6.6				
Airport ranked third	Fixed	0.6353	4.0				
Airport ranked lowest	Base	0	N/A				
One-way fare ($)	Normal	−0.0127	−20.4	0.0129	17.3	0.0129	13.3
Flight time (min)	Normal	−0.0136	−14.3	0.0065	5.0	0.0119	3.4
Access–egress time (min)	Normal	0.0108	−8.8	0.0171	9.3	0.0050	1.0
On-time performance (%)	Normal	0.0308	14.2	0.0540	17.6	0.0176	3.1
# of connections	Normal	−0.4540	−4.7	1.5086	12.3	−0.2359	−0.7
Schedule time difference (min)	Normal	−0.0052	−7.1	0.0094	8.4	−0.0018	−0.5

rho-squared relative to model with only constants = 0.16; 256 individuals; 2,560 stated preference experiments. N/A = not applicable.

TABLE 4 Estimation Results: Nonbusiness Travel Mixed Logit Model

Service Variables	Type	Coefficient	*T*-Stat	Standard Deviation	*T*-Stat	Elite Flyer Interaction	*T*-Stat
Constant (actual itinerary)	Fixed	0.1246	2.4				
Propeller	Base	0	N/A				
Regional jet	Fixed	0.3818	5.2				
Standard jet	Fixed	0.5734	7.6				
Wide-body	Fixed	1.1987	12.0				
Airline ranked first	Normal	0.7526	13.2	1.0615	15.0	0.7055	3.8
Airline ranked second	Fixed	0.4123	6.8				
Airline ranked third	Fixed	0.3794	6.0				
Airline ranked lowest	Base	0	N/A				
Airport ranked first	Normal	1.9941	22.0	1.9978	25.0	−0.2727	−1.5
Airport ranked second	Fixed	1.1529	14.1				
Airport ranked third	Fixed	0.8860	9.9				
Airport ranked lowest	Base	0	N/A				
One-way fare ($)	Normal	−0.0264	−37.1	0.0239	34.1	0.0060	7.4
Flight time (min)	Normal	−0.0120	−23.0	0.0054	7.9	0.0088	4.8
Access–egress time (min)	Normal	−0.0080	−14.3	0.0193	22.1	−0.0031	−1.4
On-time performance (%)	Normal	0.0129	12.6	0.0218	16.6	−0.0208	−6.5
# of connections	Normal	−0.3628	−8.0	1.1884	19.3	0.1574	0.9
Schedule time difference (min)	Normal	−0.0016	−6.3	0.0001	0.3	0.0009	0.7

rho-squared relative to model with only constants = 0.21; 339 individuals; 3,390 stated preference experiments. N/A = not applicable.

geneity (Table 2), all estimated service attribute coefficients have intuitively reasonable signs and magnitudes and are statistically different from zero.

As reported in previous work, explicitly accounting for heterogeneity can have significant effects on estimated mean coefficient values and, in turn, on the inferences that are drawn from the model coefficients. Comparing Tables 1 and 2 with Tables 3 and 4 illustrates those types of effects with differences up to a factor of almost 3 between equivalent statistically significant coefficients. Tables 3 and 4 include the same set of service attributes as those in Tables 1 and 2, but there are additional columns indicating the type of coefficient specified ("fixed" means assumed constant within the segment, "normal" means assumed to be normally distributed within the segment, and "base" is the base value, which is set to zero for each categorical attribute). For the coefficients that are assumed to be normally distributed, values for the additional estimated parameters—the standard deviations within the segment—are given along with the *T*-statistics for those parameters. The final two columns show the additive increment to the random coefficients that is attributed to elite membership in a frequent flier program ("Elite Flyer Interaction") and the *T*-statistic for that increment. As an example, for nonbusiness trips (Table 4), the preference for the traveler's first-ranked airline increases by 0.71 from the mean value 0.75, to 1.46, for elite-level fliers. In general, the service-level values are substantially damped for elite-level fliers. For example, for elite-level business travelers, fare sensitivity goes close to zero. However, as might be expected, the model indicates that elite-level fliers on business trips are significantly more sensitive to on-time performance than are other business travelers.

In addition to the model coefficients, marginal rates of substitution were computed between fare values and all of the random coefficients by simulating the distributions. These results are shown in Tables 5 and 6. These mixed logit model estimation results reveal a number of important service effects.

Fare

As would be expected, sensitivities to fare levels vary significantly between business and nonbusiness travelers, with the former approximately half as sensitive to fare changes as the latter. There is significant random heterogeneity in fare sensitivities. In addition, fare sensitivities for elite-level frequent fliers are significantly lower than those for other travelers.

Flight Time

Flight time as used here includes the total scheduled origin-airport-to-destination-airport trip time, including connection time, if applicable. The scheduled origin-airport-to-destination-airport trip time has a significant value across all travelers. Business travelers are willing to pay $70 (each way) for each hour of reduction in trip time. Nonbusiness travelers will pay, on average, a little less than half of

TABLE 5 Fare Substitution Values for Basic Service Variables: Business Trips

Service Variables	Mean ($)	Standard Deviation
Flight time (h)	69.7	39.2
Access–egress time (h)	62.5	41.3
On-time performance (10%)	38.2	40.8
# of connections	53.7	48.5
Schedule time difference (h)	30.3	22.9
Highest ranked airline vs. lowest	96.1	55.9
Highest ranked airport vs. lowest	145.8	52.4
Standard jet vs. propeller	32.1	N/A

TABLE 6 Fare Substitution Values for Basic Service Variables: Nonbusiness Trips

Service Variables	Mean ($)	Standard Deviation
Flight time (h)	31.2	23.2
Access–egress time (h)	26.1	28.8
On-time performance (10%)	6.4	9.1
# of connections	18.8	23.3
Schedule time difference (h)	4.8	5.7
Highest ranked airline vs. lowest	37.8	36.4
Highest ranked airport vs. lowest	87.2	53.4
Standard jet vs. propjet	21.7	N/A

that ($31 per hour). Although the actual flying times between major destinations do not vary much, there can be large differences in scheduled times because of different itineraries (for example, different airports, connections, or both) and different schedule allowances for airport congestion.

Airport Access Time

The amount of time required to get to and from the airport is valued at a rate that is not statistically different from the value assigned to airport-to-airport trip time. This finding implies, as might be expected, that airport access and egress times are as important to travelers as are in-flight travel times.

Number of Connections

Connections can have at least three types of effects on the value of an itinerary. First, an additional connection invariably adds travel time, which is accounted for, in these models, in the flight time. Second, connections can affect the on-time performance of the itinerary and that effect is also separately measured in these models. The effect that is measured here is the additional inconvenience associated with the connection. This inconvenience includes, for example, the disembarking and reboarding required, long walks (or runs) through terminals, and having to shut down and restart laptop computers.

Business travelers are especially sensitive to the number of connections in their itinerary; they perceive that each connection represents a $54 loss in value beyond the reductions in value from increased travel times and increased chance of missing the scheduled arrival time. Nonbusiness travelers place a somewhat lower, but still significant, value of about $19/connection.

The use of airport hubs allows airlines to provide service to a broader range of city pairs. However, it results in the necessity for connections for a large fraction of the longer trips and a correspondingly reduced value of that service. For business travelers in particular, large perceived penalties are associated with those extra connections.

On-Time Performance

The FAA has continued to publish data describing the on-time performance of individual flights. These data are provided to travelers by some reservation services, but certainly not by all. Those services that do not provide the data presumably exclude them because they are not inclusive of all flights and they represent past experience, which may or may not be an indicator of the experience for a future flight. However, if some of those services also believe that travelers do not care about or do not understand these indicators, the findings from this survey strongly refute that position.

Travelers react very consistently to the on-time performance measure of percent on time. Business travelers place a value of over $38 for each 10% change in on-time performance. This fact means that the perceived difference in value between a flight that is 90% on time versus one that is 85% on time would be about $20 per one-way trip per passenger. As noted earlier, elite-level fliers are even more sensitive to differences in on-time performance. The value for nonbusiness travelers is closer to $6 for a similar 10% improvement in on-time performance.

Aircraft Type

Business travelers appear to be eager to avoid propjets, but there is little difference in preference among other types of aircraft; they are willing to pay an additional $40 per trip to fly on a regional jet versus a propjet. Nonbusiness travelers are somewhat more sensitive across the range of aircraft types; they are willing to pay almost $40 extra to fly on a wide-body jet versus a propjet but less than half that amount to fly on a standard jet versus a propjet.

Airline

In the choice-based conjoint experiments, survey respondents were shown all of the standard flight details, along with an airline name. The basic service elements (fare, schedule, airport, on-time performance) were all fully specified, so the airline name was a proxy (as it is in real flight choices) for all of the unspecified service elements such as onboard amenities, frequent flier benefits, and perceived quality of service. The airline values derived from these exercises can be interpreted as the net differences of those elements.

Business travelers indicated that they are willing to pay almost $100 more to fly with their most-preferred carrier as opposed to their least-preferred airline, again assuming that all other service elements were equal between the flights. This value has increased significantly in the past year (compared with results from the 2001 survey), presumably reflecting the increased exposure of business travelers to low-cost airlines. Nonbusiness travelers assign a somewhat lower value, $38, to their preferred carrier as compared with their least preferred. The actual preferences among the major carriers vary regionally and by customer as reflected in the large standard deviations of these parameters. In addition and not surprisingly, the elite frequent fliers assign considerably higher value, on average, to their preferred airlines.

Other reports (*4, 6*) contain details of the utility values for individual airlines, and those details are not included in this paper. However, it should be noted that the utility values after the fare and other service effects are removed, as is explicitly done in this analysis, results in a mix of low-fare and conventional carriers with the highest utility values. JetBlue and Southwest have generally high carrier brand utility, as does Midwest Airlines, to those who know of their service.

Departure Airport

Respondents were asked to indicate alternative originating airports that they would consider, and these were included in the flight choices presented in the survey. The access time differences among the airports were factored out so that a value could be assigned to the airport itself.

Business travelers indicated that they assign a value of almost $150 to their most-preferred airport compared with their least-preferred airport. The preferences of nonbusiness travelers are not quite so strong—$87 for the most-preferred airport compared with the lowest-ranked airport.

Arrival Time

Survey participants were asked to indicate their most-preferred arrival time, and flights were constructed with times varying around that preferred time. The value assigned to the difference, on average, is about $30/hour for business travelers and only $5/hour for nonbusiness travelers. Among business travelers, there is considerable random heterogeneity, which appears to result from a mix of travelers who simply want to arrive at any point on a particular day and thus assign a value to the arrival time of close to zero and others who assign higher values to a particular arrival time. By contrast, there is little heterogeneity among nonbusiness travelers and most simply assign low values to deviations from a particular arrival time.

CONCLUSIONS

The work reported in this paper illustrates the application of a mixed logit approach using stated-preference survey data to the development of itinerary choice models. The empirical results demonstrate the importance of explicitly accounting for traveler preference heterogeneities by using segmentation, interaction effects, and random parameter specifications. The calculated marginal rates of substitution show the relative importance that travelers assign to key service variations among itineraries. All of the service features that were included in the model have significant values to travelers, and the values are affected, as would be expected, by the traveler's frequent flier status. Although current reservation and ticketing services provide information to prospective travelers on most of these itinerary features, most services do not report on-time performance, which, however, can be an important selection criterion for travelers. On-time performance is especially important to elite business travelers. This finding suggests that supplying data for on-time performance could substantially influence itinerary choices.

Although this work provides details on the effects of a wide range of itinerary features on itinerary choice, it does not address the differential competition among classes of itineraries, as has been explored in other studies [e.g., that by Coldren and Koppelman (*1*)]. Additional work using the revealed-preference data from the survey and analyzing segments within the two broad trip purpose segments (using latent class modeling and post hoc segmentation) provides further detail on traveler choices. The effects of in-flight amenities as explored in a separate set of conjoint exercises are also detailed in the full project reports (*4, 6*). However, the details described in this paper portray a clear picture of the key factors that influence itinerary choice and indicate that travelers trade off a number of factors in making itinerary choices. Although fare differences are clearly important, airlines, airports, and other service providers can offset even large fare differences with a variety of service features. The modeling approach used in this study also clearly demonstrates, as might be expected, that there is a significant amount of heterogeneity within the air traveler market. Quantifying this heterogeneity by using modeling techniques such as mixed logit provides additional insights that can be used to further target air service alternatives.

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