Modeling the Choice of an Airline Itinerary and Fare Product using Booking and Seat Availability Data

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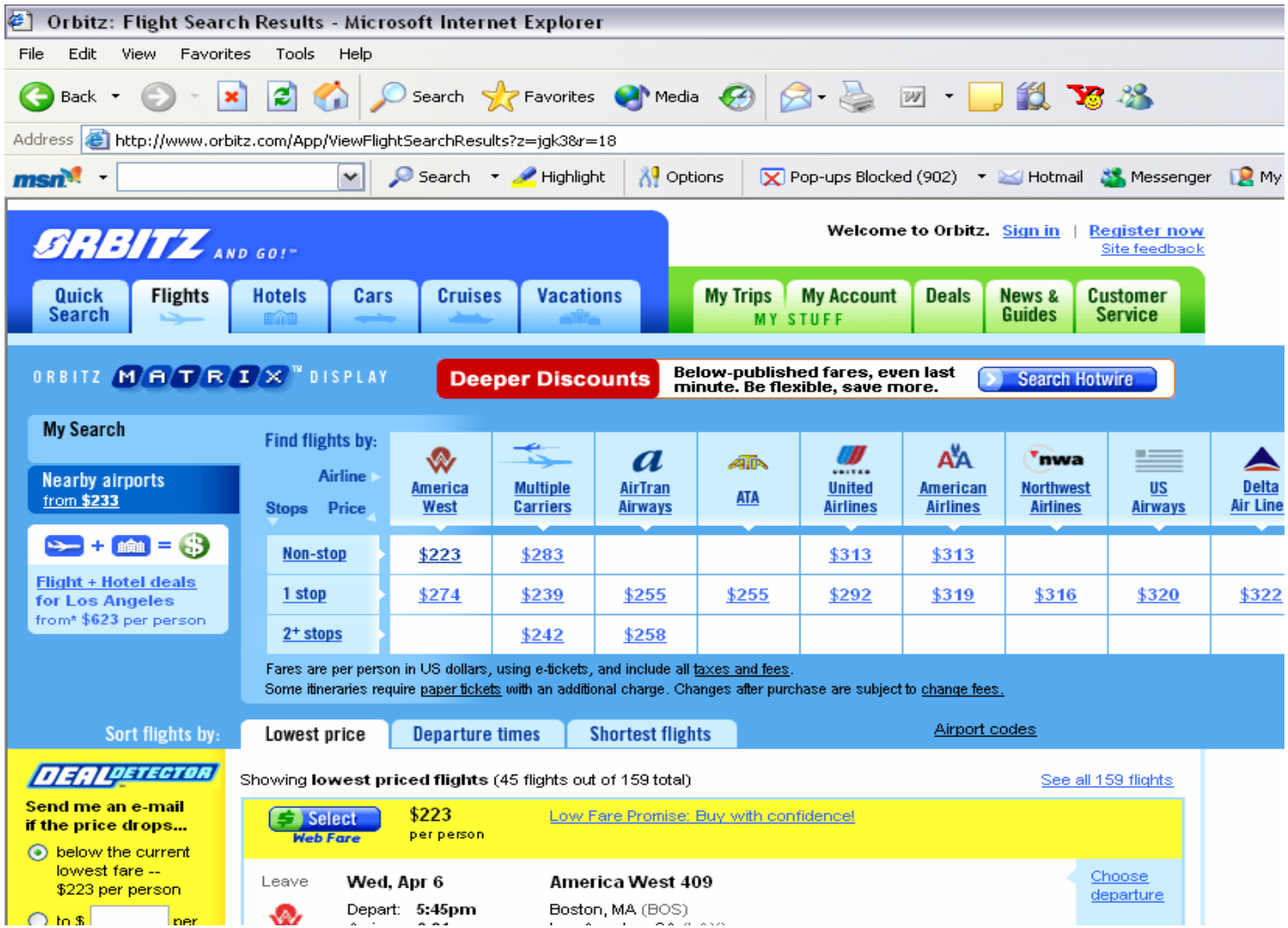
October 2007

Foreword: Consumer Choice in the Airline Industry



Motivation

- Since 2000, two major changes in the airline industry
  - ✈ New pricing practices (fare simplification)
  - ✈ Web-based distribution of airline tickets (price transparency)

- These changes have undermined traditional pricing and distribution strategies of network carriers
  - ✈ A better understanding of the key drivers of passenger choice behavior may support the design of new pricing strategies and revenue management methods

- Existing studies do not accurately represent the consumer choice environment in the airline industry
  - ✈ Focus on a single dimension such as the choice of an itinerary and fail to investigate the trade-off between price and schedule
  - ✈ Do not fully incorporate the impact of pricing and revenue management on the passenger choice set

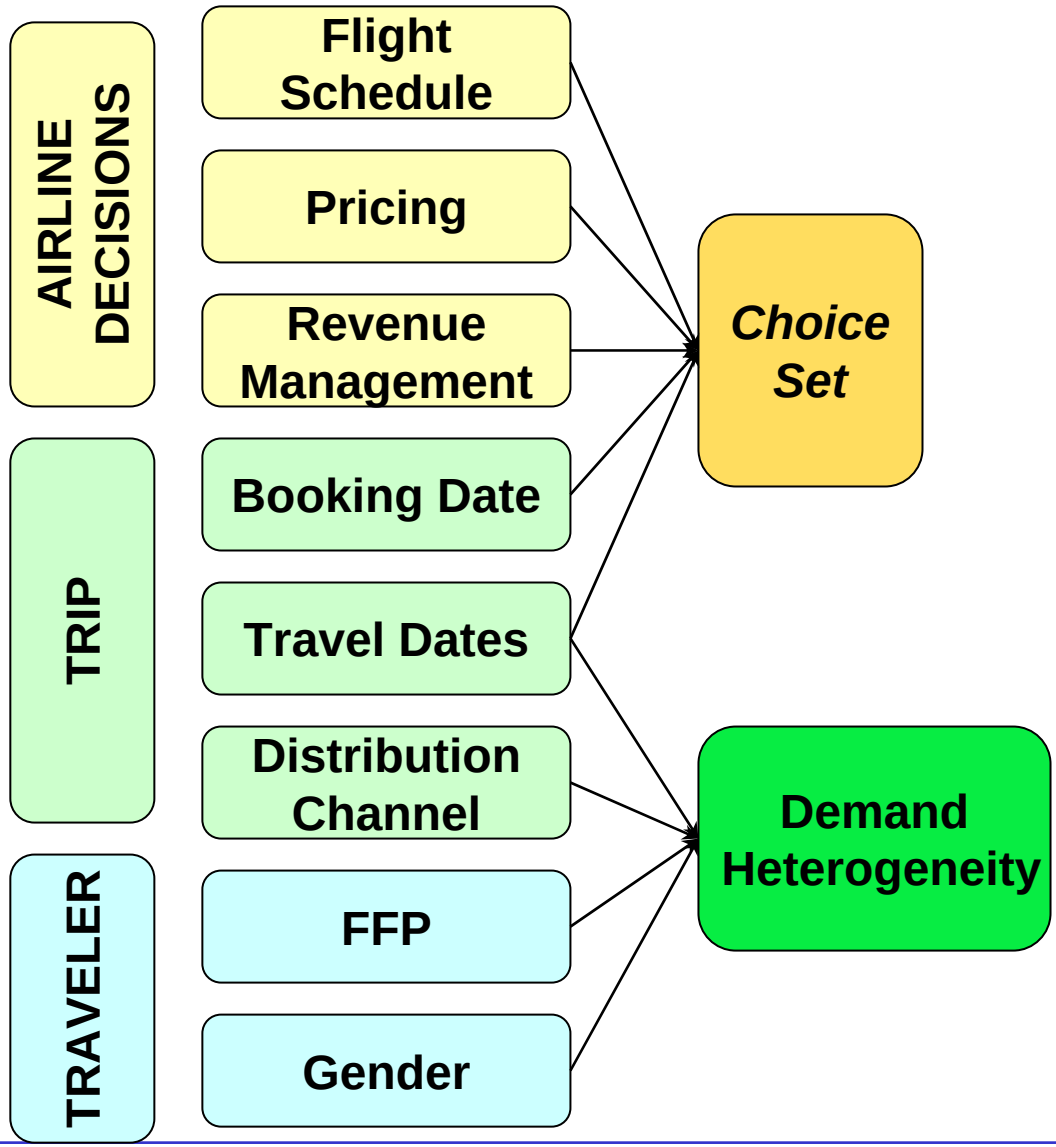
Choice of Itinerary and Fare Product

- Objective of the research:
  - ✈ Develop a multi-dimensional model of airline passenger choice based on booking data that investigates the choice preferences of different segments of airline travelers

- Focus on how an airline can exploit its existing data
  - ✈ Flight Schedule
  - ✈ Fare Rules
  - ✈ Seat Availability
  - ✈ Booking (Proprietary)

- Dependent Variable
  - ✈ Itinerary
  - ✈ Fare Product

Modeling Framework



- Booking Data Limitations
  - ✈ Passenger Choice Set
  - ✈ Trip Purpose

- Combine several data sources to reconstruct the passenger choice set for each booking
  - ✈ Collect seat availability data for future departures
  - ✈ Combine booking and seat availability data based on the date of the booking
  - ✈ Apply fare rules based on the characteristics of each booking

- Replace trip purpose by several elements extracted from booking data
  - ✈ Characteristics of the trip
  - ✈ Traveler's Profile
  - ✈ Probabilistic Approach: Latent Classes

Explanatory Variables

- Dependent Variable
  - ✈ Combination of an itinerary and a fare product
  - ✈ Non-stop itineraries

- Class Membership Model
  - ✈ Distribution Channel: Offline Travel Agent Dummy
  - ✈ Frequent Flyer Membership
  - ✈ Week Travel: MONFRI dummy

- Choice Model: Attributes of the Alternatives
  - ✈ Fare
  - ✈ Fare Product Characteristics:
    - Flexibility of travel plans in interaction with advance purchase requirements
  - ✈ Flight Departure Time: A continuous trigonometric function of time

Data Sources

- Two types of data
  - ✈ Booking
  - ✈ Seat Availability for future departures (daily extract over a three-month period)
- Data source: Amadeus
- Booking Data Collection Period
  - ✈ May 26-31, 2005
  - ✈ July 1-7, 2005
- Data collected for outbound trips in three short-haul European markets
- Sample Size: 2015 Booking Records

Fare Structure

FP Category	Product Code	OW Fare (FRA)	AP (Days)	Max Stay	Canc. Fee	Change Fee
Weekend	NWKEND	102 €	1	2 days	Not Permitted	Not Permitted
Saturday Night	NAP30	107 €	30	1 month	Not Permitted	Not Permitted
	EAP21	138 €	21	1 month	120 €	60 €
	WAP14	167 €	14	1 month	120 €	60 €
	QAP7	201 €	7	1 month	120 €	60 €
	MSX0	234 €	0	1 month	120 €	60 €
Week	AWEEK21	161 €	21	12 months	Not Permitted	Not Permitted
	UWEEK14	213 €	14	12 months	Not Permitted	Not Permitted
	UWEEK7	281 €	7	12 months	Not Permitted	Not Permitted
	RWEEK	325 €	0	12 months	Not Permitted	60 €
Flex	BFIRME	276 €	0	12 months	None	None
	SFIRME	310 €	0	12 months	None	None
	S	362 €	0	12 months	None	None

Source: Travelocity (Sabre), Amadeus

Choice Set Generation

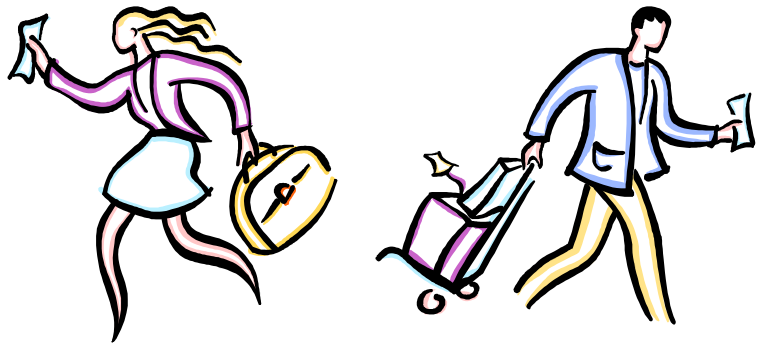
- Apply Fare Rules:
  - ✈ Eliminate a fare product if the characteristics of the booking do not satisfy the fare rules:
    - Dates of travel: Weekend, Saturday Night Stay, Maximum Stay
    - Date of the booking: Advance Purchase
- Incorporate Revenue Management Controls
  - ✈ Eliminate a fare product if no seat availability on the date of the booking
- Apply Observed Dominance Rules
  - ✈ Cheapest fare within a fare product category
  - ✈ For trips eligible for the Weekend fare product, eliminate all other fare products
  - ✈ For trips that include a Saturday Night, eliminate Week and Flex products except if no seat availability for Saturday Night Stay products
- Corporate Contract Assumption
- Day Trip

Traveler's Choice Set

Booking Date:
June 22, 2005 (AP=15)

Outbound Departure Date:
Thursday, July 7, 2005

Inbound Departure Date:
Saturday, July 9, 2005



Booking Date:
June 22, 2005 (AP=15)

Outbound Departure Date:
Thursday, July 7, 2005

Inbound Departure Date:
Monday, July 11, 2005

	FLIGHT 1	FLIGHT 2	FLIGHT 3
NWKEND	M	M	M
NAP30	M	M	M
EAP21	M	M	M
WAP14	M	M	M
QAP7	M	M	M
MSX0	M	M	M
AWEEK21	M	M	M
UWEEK14	Y	M	M
UWEEK7	M	M	M
RWEEK	M	M	M
BFIRME	M	M	M
SFIRME	M	M	M
S	Y	Y	Y

Flight 1, 6:40 a.m.:
Y9S9B9K9H9R9M9T9Q9V9L9X9U9W9E9A0N0I0

Flight 2, 7:45 a.m. :
Y9S9B9K4H4R0M0T0Q0V0L0X0U0W0E0A0N0I0

Flight 3, 10 a.m. :
Y9S9B4K3H3R0M0T0Q0V0L0X0U0W0E0A0N0I0

	FLIGHT 1	FLIGHT 2	FLIGHT 3
NWKEND	M	M	M
NAP30	M	M	M
EAP21	M	M	M
WAP14	Y	M	M
QAP7	M	M	M
MSX0	M	M	M
AWEEK21	M	M	M
UWEEK14	M	M	M
UWEEK7	M	M	M
RWEEK	M	M	M
BFIRME	M	M	M
SFIRME	M	M	M
S	M	Y	Y

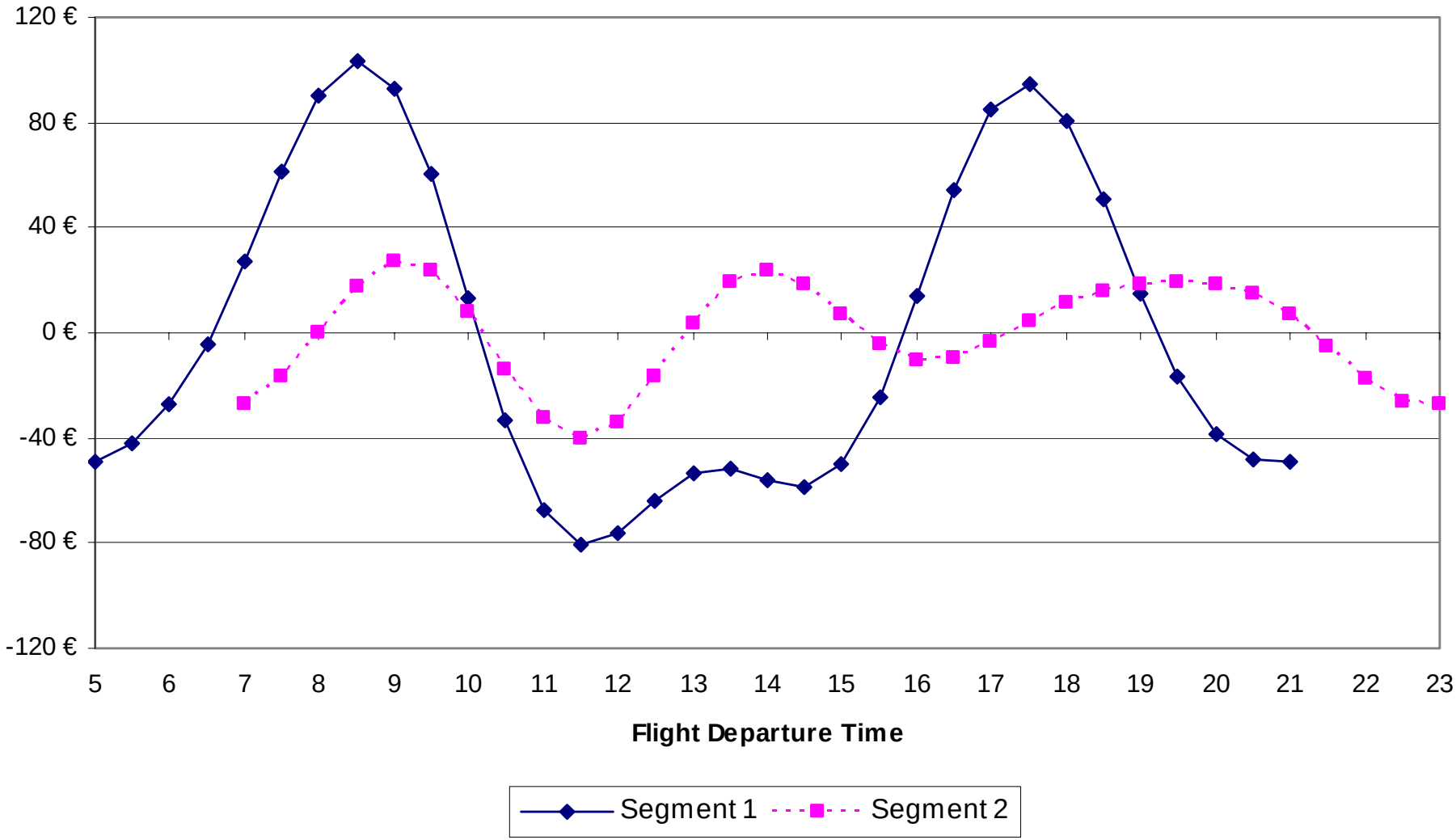
Choice: Flight1, UWEEK14, 178.58 EUR OW

Choice: Flight1, WAP14, 116.08 EUR OW

Estimation Results: Latent Class Choice Model

SEGMENT SIZE	2-class Model							
	Segment 1 75.1%				Segment 2 24.9%			
	Est.	Std. Er.	t-stat	WTP	Est.	Std. Er.	t-stat	WTP
Intercept	-3.91	1.24	-3.2					
Offline TA	3.01	1.02	3.0					
FFP Member	0.94	0.43	2.2					
MONFRI	2.71	1.03	2.6					
FARE	-0.0125	0.0054	-2.3		-0.0273	0.0076	-3.6	
NOFLEX21+	-2.45	1.10	-2.2	-195.64 €	-3.71	1.27	-2.9	-135.91 €
NOFLEX7/14	-2.27	0.69	-3.3	-181.88 €	-1.48	0.86	-1.7	-54.39 €
NOFLEXNOAP	-1.35	0.26	-5.2	-107.75 €	0.00	0.48	0.0	0.11 €
SIN2PI16NODT	-0.13	0.07	-1.7		-0.22	0.13	-1.8	
SIN4PI16NODT	0.68	0.10	6.9		0.03	0.14	0.2	
SIN6PI16NODT	0.30	0.06	5.1		-0.18	0.09	-2.0	
SIN8PI16NODT	-0.24	0.08	-2.9		-0.23	0.13	-1.8	
COS2PI16NODT	0.34	0.09	4.0		0.02	0.13	0.2	
COS4PI16NODT	-0.56	0.12	-4.7		-0.09	0.22	-0.4	
COS6PI16NODT	-0.16	0.11	-1.5		-0.59	0.19	-3.1	
COS8PI16NODT	0.03	0.13	0.2		0.17	0.23	0.8	
SIN2PI9DT	2.27	0.34	6.7		4.89	2.90	1.7	
COS2PI9DT	0.44	0.13	3.3		-1.50	1.21	-1.2	
Log L (0)	-3516.81							
Log L	-3142.46							

Time-of-Day Preferences: Passenger WTP for a Flight Departure Time



Airline Planning Applications

- Apply choice models to analyze airline planning decisions that involve a change in
  - ✈ Attributes of the Alternatives
  - ✈ Traveler's Choice Set
- Scheduling
  - ✈ Timetable Design (Time-of-day Preferences)
- Pricing
  - ✈ Fare Product Design (Restrictions, Fare Product Characteristics)
- Revenue Management
  - ✈ New revenue management algorithms for less restricted fare structures require an estimate of sell-up behavior
  - ✈ Apply choice model estimates to evaluate sell-up behavior

Application: Estimated Sell-up Rates

	Deterministic (WEEK)	Latent Class
NAP30 (99 EUR) ⬇ EAP21 (122 EUR) MIDDAY DEPARTURE	59.7%	61.6%
AWEEK21 (165 EUR) ⬇ UWEEK14 (206 EUR) AM DEPARTURE	55.5%	44.7%

- Two-class models lead to a lower sell-up rate for week fares, as some bookings are estimated to primarily belong to segment 2 due to their characteristics (Distribution Channel, FFP)

- Limitations
  - ✈ Single-Airline Framework
  - ✈ No Travel

Conclusion

- Identified two separate segments of air travel demand
  - ✈ Heterogeneity of behavior is primarily driven by the characteristics of the trip and the underlying fare structure
  - ✈ Different behavioral characteristics across segments
    - Time-of-day Preferences
    - Flexibility in Travel Plans

- Latent class choice models provide a more flexible and richer behavioral framework
  - ✈ Segment demand using a wide range of criteria available in booking records without increasing the number of segments
  - ✈ Provides a more accurate estimate of sell-up potential than previous models based on a deterministic segmentation of airline demand