A Study on Airlines' Schedule Block Time Adjustment Behavior

Emma Ding
wzding@berkeley.edu

Introduction

Using discrete choice models—multinomial logit model (MNL), nested logit model (NL) and cross nested model (CNL), this study identifies the factors that affect airlines' schedule block time (SBT) and quantifies their impact. We defined schedule block time as the time difference between scheduled departure and arrival times. We examined three discrete SBT adjustment behaviors: increase, decrease and no change (refers to within 1% change) by analyzing observations from the previous year to predict the behavior of the next one. First performed analysis on a full dataset with flights from all airlines between 2008 and 2014, then we specified models separately for one legacy airline—American Airlines (AAL), and a regional airline—SkyWest Airlines (SKW) and compared their behaviors.

Findings

- Airlines have a tendency to increase SBT based on the results of the nested logit model
- Earliness in the previous year leads to smaller SBT in the following year
- AAL and SKW behave differently in setting SBT: Both SBT models have nested structures, but the configuration is dissimilar – AAL clusters increase and not increase in the first level, with not change and decrease in a sublevel, while SKW does in an opposite way
- Cross nested structure was identified in none of the models
- The signs of parameters associated with ABT distributions are all consistent, indicating different percentiles of ABT have same direction towards SBT change, but amplitude vary
- Different signs are found for year and quarter related coefficients, suggesting that AAL and SKW dispatchers tend to weight differently for yearly and quarterly influences

RP Data Preparation

- FAA Aviation System Performance Metrics (ASPM) flight level data, including information on scheduled and actual times and delays for specific flights
- Domestic and weekday flights only
- Year 2008 to 2014
- In total, 145,565 flights

Table 1. Flight group data aggregation criteria

Year	SBT setting year
Quarter	SBT setting quarter, 4 quarter each year
Departure airport	Origin airport
Arrival airport	Destination airport
Aircraft type	Aircraft type
Departure hour	Departure time, using hour as interval

Table 2. Statistics calculated for each group of data

$\overline{\Delta SBT}$	Difference between this and last year's mean SBT
ABT15	15 percentile of last year's ABT
ABT50	50 percentile of last year's ABT
ABT70	70 percentile of last year's ABT
ABT85	85 percentile of last year's ABT
ABTaad	mean of $\lvert X_i - \mathrm{mean}(X_0 \text{ to } X_n)\rvert$, X represents last year's ABT
ABTmad	medium of $\lvert X_i - \mathrm{medium}\ (X_0 \text{ to } X_n)\rvert$, X represents last year's ABT
ABTsd	Standard deviation of last year's ABT
Ontime percentage	last year's on-time percentage = number of on-time flight / total flight number
Earliness	last year's flight earliness = number of early flight / total flight number

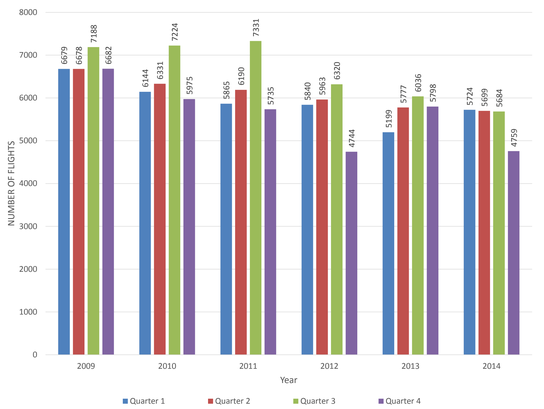


Figure 1. Total number of flights for each quarter from 2008 to 2014

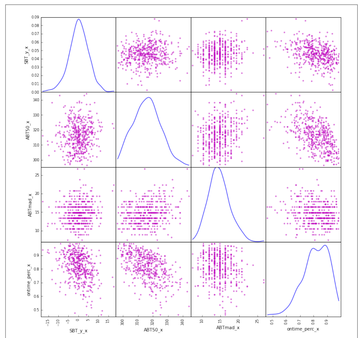


Figure 2. Correlation matrix of $\overline{\Delta SBT}$, 50% ABT, madABT and on-time percentage of LAX-JFK

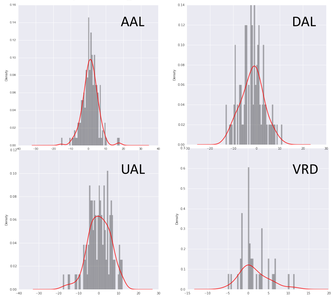


Figure 3. $\overline{\Delta SBT}$ distribution, LAX-JFK

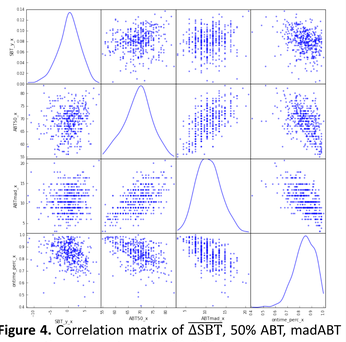


Figure 4. Correlation matrix of $\overline{\Delta SBT}$, 50% ABT, madABT and on-time percentage of LGA-BOS

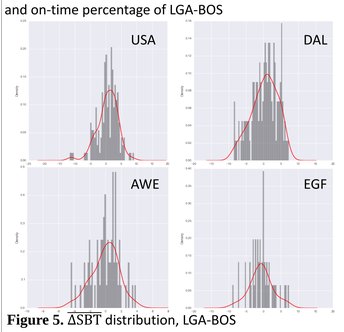
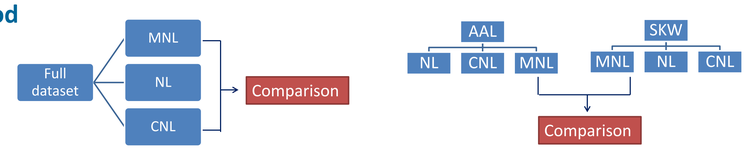
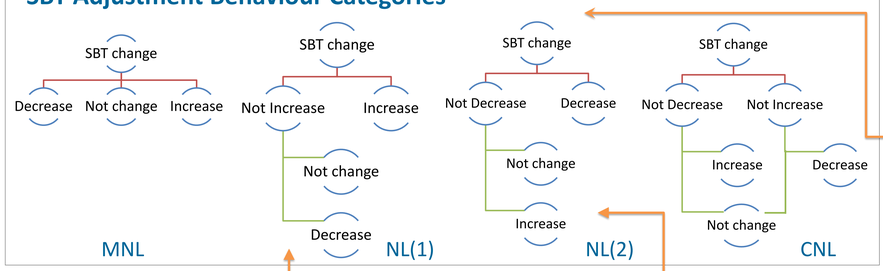


Figure 5. $\overline{\Delta SBT}$ distribution, LGA-BOS

Method



SBT Adjustment Behaviour Categories



Parameter	Value	Std err	t-test	Parameter	Value	Std err	t-test
ASC_Decrease	-3.03	0.138	-22.02	Q4De	0.0458	0.0171	2.68
ASC_Increase	0.534	0.158	3.38	Q4In	-0.00472	0.00587	-0.80
SBTmeanDe	-0.349	0.0272	-12.84	Year2010De	0.163	0.0212	7.68
SBTmeanIn	-0.198	0.0589	-3.36	Year2010In	-0.0513	0.0161	-3.20
ABTmadDe	0.611	0.0410	14.92	Year2011De	0.204	0.0222	9.17
ABTmadIn	0.244	0.0728	3.35	Year2011In	-0.0703	0.0213	-3.30
EarlinessDe	4.02	0.118	34.15	Year2012De	-0.0852	0.0212	-4.02
EarlinessIn	-0.800	0.236	-3.39	Year2012In	-0.0260	0.00986	-2.64
Q2De	0.0367	0.0172	2.14	Year2013De	0.00299	0.0218	0.14
Q2In	-0.0219	0.00873	-2.50	Year2013In	-0.0454	0.0150	-3.03
Q3De	0.0613	0.0167	3.66	Year2014De	-0.118	0.0232	-5.08
Q3In	-0.00199	0.00563	-0.35	Year2014In	-0.0632	0.0201	-3.15
μ_{De_NotDe}	3.48	1.03	3.37				
# of obs	145565						
# of parameters	25						
Final Log-likelihood	-147194.679						
Rho-squares	0.089						

	MNL			NL		
Parameter	Value	Std err	t-test	Value	Std err	t-test
ABT50De	-0.384	0.0335	-11.45	-0.146	0.0605	-2.42
ABT70In	-0.438	0.0319	-13.70	-0.358	0.0360	-9.94
ABTaadDe	0.240	0.0703	3.41	0.0879	0.0452	1.94
ABTaadIn	1.35	0.173	7.81	1.20	0.174	6.91
ABTsdIn	-0.234	0.105	-2.22	-0.244	0.105	-2.32
EarlinessDe	4.88	0.225	21.75	1.89	0.760	2.49
EarlinessIn	-5.65	0.194	-29.09	-6.43	0.270	-23.79
OntimeDe	-3.97	0.202	-19.70	-1.54	0.620	-2.49
OntimeIn	3.90	0.161	24.20	4.12	0.163	25.26
Q2In	-0.122	0.0447	-2.73	-0.101	0.0447	-2.25
Q3De	0.257	0.0496	5.19	0.104	0.0452	2.30
Q3In	0.0971	0.0470	2.07	0.0567	0.0447	1.27
Q4De	0.423	0.0482	8.78	0.187	0.0738	2.54
Year2010De	0.361	0.0743	4.86	0.134	0.0616	2.17
Year2010In	-0.307	0.0663	-4.63	-0.407	0.0653	-6.24
Year2011De	0.437	0.0752	5.81	0.172	0.0737	2.34
Year2011In	-0.469	0.0699	-6.71	-0.581	0.0705	-8.25
Year2012De	0.206	0.0763	2.70	0.0902	0.0442	2.04
Year2012In	-0.346	0.0673	-5.14	-0.404	0.0645	-6.27
Year2013De	-0.675	0.0870	-7.76	-0.249	0.107	-2.33
Year2013In	0.235	0.0632	3.71	0.333	0.0640	5.20
Year2014De	0.715	0.0738	9.69	0.276	0.114	2.42
Year2014In	-0.568	0.0698	-8.14	-0.756	0.0793	-9.54
μ_{In_NotIn}		---		2.70	1.10	2.45
# of obs	16200					
# of parameters	23			24		
Final Log-likelihood	-15775.146			-15767.618		
Rho-squares	0.114			0.119		

Table 3. Estimation results of Nested Logit model using full dataset

Table 4. Estimation results of best MNL and NL model for American Airlines (AAL)

Table 5. Estimation results of best MNL and NL model for SkyWest Airlines (SKW)

	MNL			NL		
Parameter	Value	Std err	t-test	Value	Std err	t-test
ABT70De	-0.869	0.0704	-12.34	-0.461	0.141	-3.28
ABT70In	-1.20	0.0637	-18.87	-0.463	0.230	-2.01
ABTaadDe	1.05	0.289	3.65	0.837	0.288	2.90
ABTaadIn	0.716	0.121	5.89	0.280	0.145	1.93
ABTsdDe	-0.577	0.167	-3.45	-0.581	0.167	-3.48
EarlinessDe	6.13	0.249	24.66	8.07	0.633	12.75
EarlinessIn	-5.25	0.214	-24.49	-2.00	0.995	-2.01
OntimeDe	-5.12	0.328	-15.62	-6.09	0.417	-14.60
OntimeIn	2.83	0.279	10.13	1.11	0.552	2.01
Q2De	-0.156	0.0458	-3.41	-0.153	0.0458	-3.35
Q4De	-0.152	0.0553	-2.75	-0.102	0.0503	-2.03
Q4In	-0.122	0.0503	-2.43	-0.0458	0.0296	-1.55
ASC_Decrease	1.78	0.219	8.11	0.538	0.408	1.32
SBTincrease	1.78	0.199	8.92	0.640	0.334	1.91
Year2010De	0.162	0.0582	2.78	0.228	0.0613	3.72
Year2011In	0.359	0.0533	6.73	0.151	0.0788	1.92
Year2012De	-0.367	0.0713	-5.15	-0.569	0.0804	-7.08
Year2012In	0.656	0.0614	10.68	0.236	0.124	1.90
Year2013De	-0.539	0.0640	-8.41	-0.540	0.0563	-9.59
Year2013In	0.199	0.0566	3.50	0.0893	0.0464	1.92
Year2014De	-1.01	0.0593	-17.05	-0.951	0.0616	-15.45
μ_{De_NotDe}		---		2.71	1.36	1.99
# of obs	16177					
# of parameters	21			22		
Final Log-likelihood	-14896.318			-14891.253		
Rho-squares	0.162			0.174		

Future Research

- Taking information about new facilities, such as runways, taxiways, etc. improvement into consideration, because this would also contribute to SBT change.
- For the purpose of this study, I set "not change" equals to SBT change within 1%. Different thresholds could be applied and tested in the future.
- It is hard to interpret ABT distribution-related parameters (see figure on the right), thus Joint discrete-continuous model is recommended to better understand airlines' preference, which would consider SBT change as discrete choice making, while the relationship between ABT and SBT as a regression model.