

A Study on Airlines' Schedule Block Time Adjustment Behavior

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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.



CNL

Method

Findings

Decrease

Logit

CNL

model

model

Airlines

 $\mu_{De\ NotDe}$

of obs

of parameters

Final Log-likelihood

Rho-squares

Comparison

- 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

Table 11 Highle Broad adda aggregation enterna					
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

	6 6 8 6
$\overline{\Delta \mathrm{SBT}}$	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 $ X_i - mean(X_0 \text{ to } X_n) $, X represents last year's ABT
ABTmad	medium of $ X_i - medium (X_0 \text{ to } X_n) $, 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

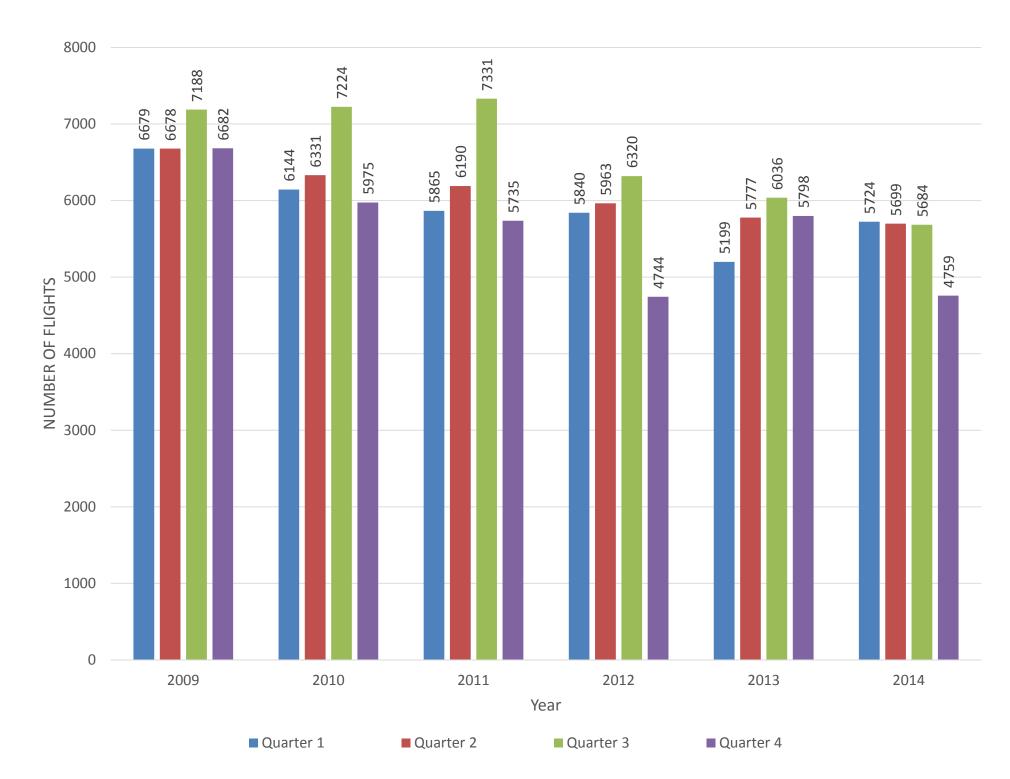
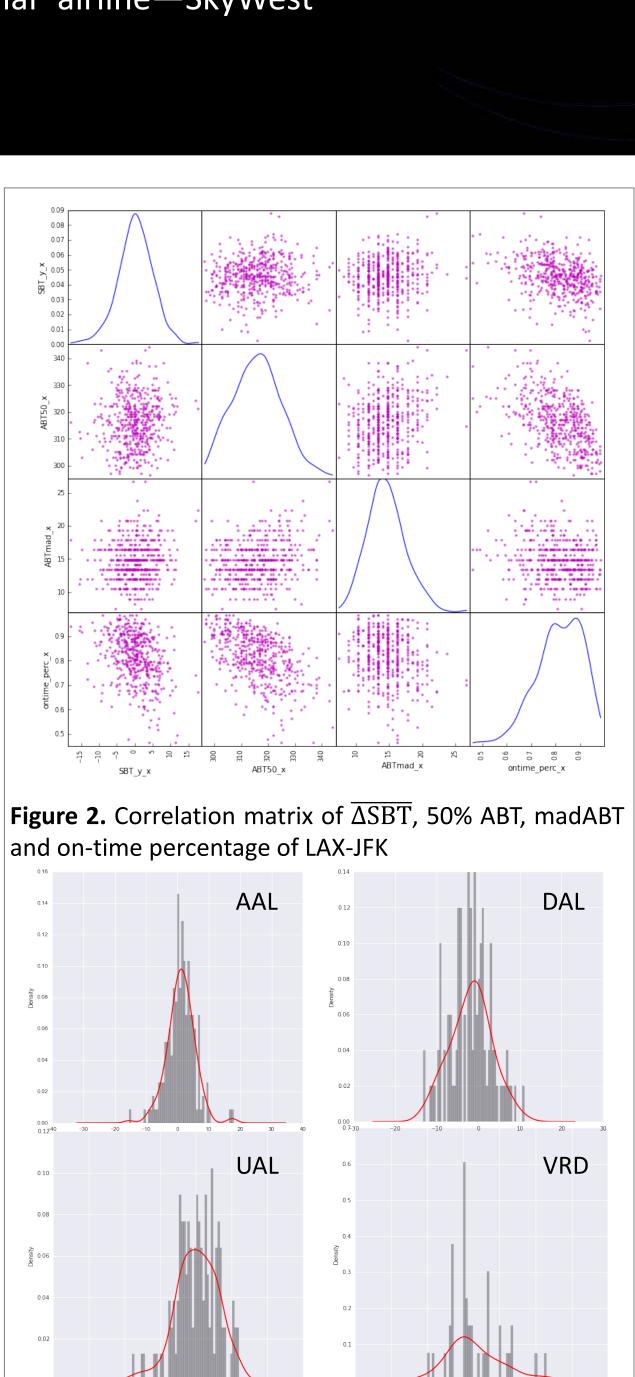


Figure 1. Total number of flights for each quarter from 2008 to 2014



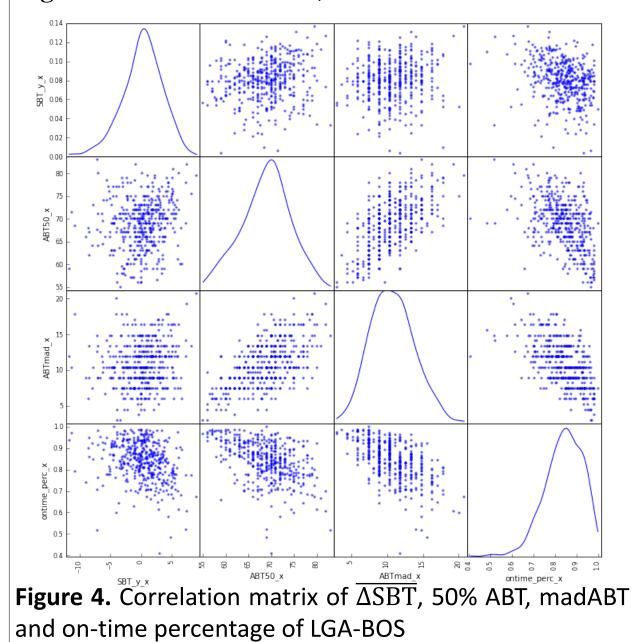
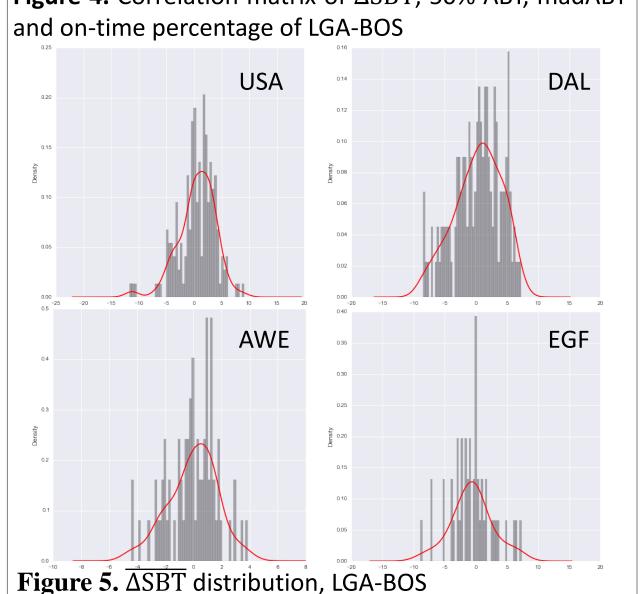


Figure 3. $\overline{\Delta SBT}$ distribution, LAX-JFK



SBT Adjustment Behaviour Categories SBT change SBT change SBT change SBT change Decrease Not change Increase Not Decrease Not Decrease Not Increase Not change Increase Not change Increase Not change Decrease **NL(2)** MNL NL(1) MNL **Table** NL Value Std err Std err t-test t-test **Parameter** Estimation results -0.384 0.0335 -11.45 -0.146 0.0605 ABT50De of Nested 0.0319 -13.70 -0.358 0.0360 ABT70In model using full 1.94 0.240 3.41 0.0879 **ABTaadDe** 0.0703 0.0452 dataset **ABTaadIn** 1.35 0.173 7.81 1.20 0.174 6.91 **ABTsdIn** -0.244 0.105 -2.32 2.49 0.225 21.75 0.760 Table **EarlinessDe** -29.09 -6.43 0.270 **EarlinessIn** Estimation results -19.70 -2.49 0.202 0.620 OntimeDe of best MNL and 24.20 0.163 25.26 0.161 4.12 OntimeIn -0.101 0.0447 American Airlines 2.30 0.0452 0.0496 5.19 (AAL) 0.0971 0.0447 0.0470 0.0567 1.27 Q4De 0.187 2.54 0.0482 0.0738 0.361 2.17 Year2010De 0.0743 4.86 0.134 0.0616 Table -6.24 -0.307 0.0653 Year2010In 0.0663 -4.63 -0.407 Estimation results 0.437 0.0752 0.172 0.0737 5.81 Year2011De of best MNL and -0.581 -0.469 0.0699 -6.71 Year2011In 2.04 2.70 0.0902 0.0442 Year2012De 0.0763 SkyWest -0.346 0.0673 -0.404 0.0645 -6.27 Year2012In -5.14 -2.33 Year2013De 0.0870 -0.249 0.107 0.0640 0.235 0.0632 3.71 0.333 5.20 Year2013In 0.0738 0.276 0.114 Year2014De 9.69 2.42 -9.54 Year2014In -0.568 0.0698 -0.756 0.0793 2.70 1.10 2.45 μ_{In_NotIn} # of obs 16200 23 # of parameters 24 Final Log-likelihood -15775.146 -15767.618

0.114

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				
. 20_110020	# of obs				14556	 5	
#		25					
•					-147194.	679	
		0.089)				
			MNI			NI	
Parameto	er	Value		t-test	Value		t-test
		-0.869	0.0704	-12.34	-0.461	0.141	-3.28
ABT70Ir	า	-1.20	0.0637	-18.87	-0.463	0.230	-2.01
ABTaadD	10	1.05	0.289	2.65	0.927	U 388	2.90
	<i>j</i> e	1.05	0.203	3.65	0.657	0.200	2.50
ABTaadI		0.716	0.121	5.89	0.280	0.288	1.93
ABTaadl ABTsdD	n						
	n e	0.716	0.121	5.89	0.280	0.145	1.93
ABTsdD	n e De	0.716 -0.577	0.121 0.167	5.89 -3.45	0.280 -0.581	0.145 0.167	1.93 -3.48
ABTsdD EarlinessI	n e De In	0.716 -0.577 6.13	0.121 0.167 0.249	5.89 -3.45 24.66	0.280 -0.581 8.07	0.145 0.167 0.633	1.93 -3.48 12.75
ABTsdDo EarlinessI Earliness	n e De In	0.716 -0.577 6.13 -5.25	0.121 0.167 0.249 0.214	5.89 -3.45 24.66 -24.49	0.280 -0.581 8.07 -2.00	0.145 0.167 0.633 0.995	1.93 -3.48 12.75 -2.01
ABTsdDo EarlinessI Earliness OntimeD	n e De In	0.716 -0.577 6.13 -5.25 -5.12	0.121 0.167 0.249 0.214 0.328	5.89 -3.45 24.66 -24.49 -15.62	0.280 -0.581 8.07 -2.00 -6.09	0.145 0.167 0.633 0.995 0.417 0.552 0.0458	1.93 -3.48 12.75 -2.01 -14.60
ABTsdDo EarlinessI Earliness OntimeD OntimeI Q2De Q4De	n e De In	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03
ABTsdDe Earlinessl Earliness OntimeD Ontimel Q2De Q4De Q4In	n e De In Oe n	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152 -0.122	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553 0.0503	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75 -2.43	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102 -0.0458	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503 0.0296	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03 -1.55
ABTsdDe Earlinessl Earliness OntimeD Ontimel Q2De Q4De Q4De Q4In ASC_Decre	n e De In De n	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152 -0.122 1.78	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553 0.0503 0.219	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75 -2.43 8.11	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102 -0.0458 0.538	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503 0.0296 0.408	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03 -1.55 1.32
Earliness Earliness OntimeD OntimeD Q2De Q4De Q4De Q4In ASC_Decre	n e De In De n	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152 -0.122 1.78 1.78	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553 0.0503 0.219 0.199	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75 -2.43 8.11 8.92	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102 -0.0458 0.538 0.640	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503 0.0296 0.408 0.334	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03 -1.55 1.32 1.91
Earliness Earliness OntimeD OntimeD Q2De Q4De Q4De Q4In ASC_Decre SBTincrea Year2010	n e De In De ase ise De	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152 -0.122 1.78 1.78 0.162	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553 0.0503 0.219 0.199 0.0582	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75 -2.43 8.11 8.92 2.78	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102 -0.0458 0.538 0.640 0.228	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503 0.0296 0.408 0.334 0.0613	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03 -1.55 1.32 1.91 3.72
Earliness Earliness OntimeD OntimeD Q2De Q4De Q4De Q4In ASC_Decre SBTincrea Year2010 Year2011	n e De In e n e ase se De	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152 -0.122 1.78 1.78 0.162 0.359	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553 0.0503 0.219 0.199 0.199 0.0582 0.0533	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75 -2.43 8.11 8.92 2.78 6.73	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102 -0.0458 0.538 0.640 0.228 0.151	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503 0.0296 0.408 0.334 0.0613 0.0788	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03 -1.55 1.32 1.91 3.72 1.92
ABTsdDe Earliness Earliness OntimeD OntimeD Q2De Q4De Q4De Q4In ASC_Decre SBTincrea Year2010 Year2011 Year2012	n e De In e n e ase se De In De	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152 -0.122 1.78 1.78 0.162 0.359 -0.367	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553 0.0503 0.219 0.199 0.199 0.0582 0.0533 0.0713	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75 -2.43 8.11 8.92 2.78 6.73 -5.15	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102 -0.0458 0.538 0.640 0.228 0.151 -0.569	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503 0.0296 0.408 0.334 0.0613 0.0788 0.0788	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03 -1.55 1.32 1.91 3.72 1.92 -7.08
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Earliness Earliness OntimeD OntimeD Q2De Q4De Q4De Q4In ASC_Decre SBTincrea Year2010 Year2011 Year2012 Year2012	n e De In e ase se De In De In De In De	0.716 -0.577 6.13 -5.25 -5.12 2.83 -0.156 -0.152 -0.122 1.78 1.78 0.162 0.359 -0.367 0.656 -0.539	0.121 0.167 0.249 0.214 0.328 0.279 0.0458 0.0553 0.0503 0.219 0.199 0.199 0.0582 0.0533 0.0713 0.0614 0.0640	5.89 -3.45 24.66 -24.49 -15.62 10.13 -3.41 -2.75 -2.43 8.11 8.92 2.78 6.73 -5.15 10.68 -8.41	0.280 -0.581 8.07 -2.00 -6.09 1.11 -0.153 -0.102 -0.0458 0.538 0.640 0.228 0.151 -0.569 0.236 -0.540	0.145 0.167 0.633 0.995 0.417 0.552 0.0458 0.0503 0.0296 0.408 0.334 0.0613 0.0788 0.0788 0.0804 0.124 0.0563	1.93 -3.48 12.75 -2.01 -14.60 2.01 -3.35 -2.03 -1.55 1.32 1.91 3.72 1.92 -7.08 1.90 -9.59
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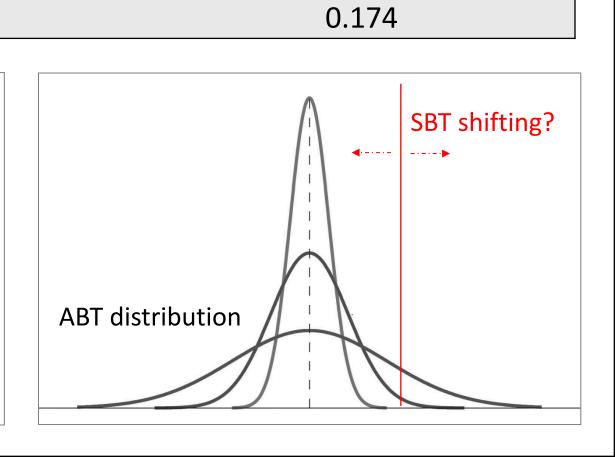
Future Research

Rho-squares

- Taking information about new facilities, such as runways, taxiways, etc. improvement into consideration, because this would also contribute to SBT
- 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.

0.119

• 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.



1.36

-14891.253

2.71

16177

-14896.318

0.162