

The Effects of Schedule Unreliability on Departure Time Choice

**NEXTOR Research Symposium
Federal Aviation Administration Headquarters**

Presented by:
Kevin Neels and Nathan Barczi

January 15, 2010

Introduction

We analyze the determinants of passengers' decision of when in the day to travel.

Expected delay causes passengers to fly earlier than they otherwise would – in some cases, the night before they need to arrive at their destination.

We estimate the value of the time lost by passengers to such voluntary schedule adjustment.

We also present a preliminary analysis of how the value of passengers' time varies according to the setting in which it is spent.

- ◆ Clearing security
- ◆ Waiting in the terminal or airport lounge
- ◆ Seated in the plane with laptops stowed, or with laptops available for work

Origin and Destination Survey (DB1B)

- ◆ A 10% quarterly sample of airline tickets from reporting carriers collected by the Office of Airline Information of the Bureau of Transportation Statistics. Data include origin, destination and other itinerary details of passengers transported. Used to generate counts of passengers by itinerary and period.

On-Time Performance Database

- ◆ Contains scheduled and actual departure and arrival times reported by certified U.S. air carriers that account for at least one percent of domestic scheduled passenger revenues. The data are collected by the Office of Airline Information, Bureau of Transportation Statistics (BTS). Used to measure information about delay, cancellations, and total trip time, by itinerary and period

Sabre

- ◆ Sabre is the oldest and the largest of the original airline computerized reservation systems, covering a large but not necessarily representative fraction of the total universe of air travel. It tends to over-represent travel booked through travel agencies, and corporate travel, making Sabre a well-equipped and suitable laboratory for investigating hypotheses about business travel behavior. Our departure time analysis sample was derived from Sabre information, which includes information about passenger departure time decisions.

Sabre

- ◆ Contains data on passenger itineraries as booked, including time of departures and arrivals
- ◆ Also captures the carrier, the fare, and the airport endpoints of each flight segments
- ◆ We requested a stratified sample covering 767 of the most heavily-traveled origin-destination pairs in the continental U.S.
- ◆ Received quarterly data for 755 origin-destination pairs observed in the Sabre dataset in 2006-2008.
- ◆ Analyzed outbound one-way trips from itineraries completed within a single five-day workweek.
- ◆ Final sample covered 89,669,995 passenger trips.

Departure times in Sabre dataset are not identified precisely.
Departures fall into one of five temporal windows:

- ◆ **Early (Midnight to 8am)**
- ◆ **AM Peak (8am to 10am)**
- ◆ **Midday (10am to 4pm)**
- ◆ **PM Peak (4pm to 7pm)**
- ◆ **Evening (7pm to Midnight)**

Model

- ◆ We assume that a passenger, given an airport pair, seeks to maximize utility across departure windows.
- ◆ We model utility as being a function of the time at which the passenger can expect to arrive at his or her destination and of the delay the passenger can expect to experience.
- ◆ We estimate the model as a standard conditional logit model, in which the probability of selecting a given departure window is a function of its characteristics and those of the other departure windows in the choice set.

Lateness

- ◆ We measure lateness as the probability of arriving more than one half hour after the scheduled departure time
- ◆ We use the on time performance database to compute empirical probability distributions for late arrivals
- ◆ Our lateness measure reflects probabilities calculated separately for each route/time period/departure window combination

Results

Left-Hand Variable is Choice of Departure Window

Observations (Trips) = 4,258,827

Variable	
Inverse of Flights per Hour	-0.376*** (0.002)
Arrival 6am-8am	2.044*** (0.021)
Arrival 8am-10am	2.020*** (0.020)
Arrival 10am-12pm	1.556*** (0.020)
Arrival 12pm-2pm	1.455*** (0.021)
Arrival 2pm-4pm	1.836*** (0.020)
Arrival 4pm-6pm	2.311*** (0.020)
Arrival 6pm-12am	0.839*** (0.020)
Cell-Specific Lateness: Early, Lag 4 qtrs	-0.0641*** (0.009)
Cell-Specific Lateness: Greater than 30 Minutes Late, Lag 4 qtrs	-0.204*** (0.014)

Notes:

Arrival and Lateness variables are probabilities expressed in decimal terms, i.e. 5% = 0.05.

Arrival prior to 6am and lateness between 0 and 30 minutes are excluded.

*** p<0.01, ** p<0.05, * p<0.1

Voluntary Schedule Adjustment Costs

- ◆ For each departure window, we recalculate the number of flights predicted if the probability of delay greater than half an hour is set to zero for that departure window only.
- ◆ We assume that passengers anticipate delay by traveling earlier than they would if they were sure of an on-time arrival.
- ◆ Thus, with no delay, we assume that passengers would switch into each departure window from the preceding window – *e.g.*, from Early to AMPeak, from AMPeak to Midday, etc.

Voluntary Schedule Adjustment Costs

Departure Category	Predicted Trips in Sample	Predicted Trips in Sample - No Delay in Departure Window	Predicted Difference	Predicted Trips in Previous Departure Window
Early	848,661	854,467	5806	3.03%
AMPeak	900,058	910,781	10722	1.26%
Midday	1,666,114	1,692,946	26832	2.98%
PMPeak	652,072	675,415	23343	1.40%
Evening	191,922	200,400	8478	1.30%
<i>Total</i>	<i>4,258,827</i>			

Voluntary Schedule Adjustment Costs

Activity	Value of Time as Multiple of Average Hourly Wage
Leisure	0.93
Work	1.86
Sleep	5.67

- ◆ We translate the hours saved by such switching into monetary values.
- ◆ We utilize an empirical study presenting estimates of how traveler value of time varies over the course of the day (Mehndiratta, Shomik Raj, 1996, “Time-of-Day Effects in Inter-City Business Travel,” *Institute of Transportation Studies at UC Berkeley Dissertation Series*).

Voluntary Schedule Adjustment Costs

Activity	Value of Time as Multiple of Average Hourly Wage
Leisure	0.93
Work	1.86
Sleep	5.67

- ◆ The value of time we express is in terms of the hourly wage of a ‘representative passenger’ (private sector production workers, 2006-2008 average – BLS)
- ◆ We assume that a passenger that adjusts from an AMPeak departure to an Early departure loses sleep time, and that a passenger that adjusts from an early departure time to a departure the night before loses leisure time. All others lose work time.

Results

Estimated Totals for 2007 Without Delay

Early to AMPeak Switches	708,416
AMPeak to Midday Switches	1,557,251
Midday to PMPeak Switches	954,852
PMPeak to Evening Switches	317,631
Evening to Next-Day Early Switches	290,309
Hours Saved	13,715,881
Passenger Time Cost Savings	\$ 539,082,730
Total Passenger Cost Savings	\$ 589,015,924

- ◆ Total Passenger Cost Savings include the average cost of a one-night stay in a hotel and a meal for each Evening to Next-Day Early Switch.

Context-Specific Time Valuation

- ◆ Time Utilization Strategies
 - Business travelers have focused increasing attention on using delay time as productively or as enjoyably as the situation permits.
 - Electronic communication has become a complement as well as a substitute for air travel, enabling business travelers to work productively in situations where this would not previously have been possible.
 - A further manifestation of efforts to utilize travel time more productively is growing demand for access to airport lounges.
 - The time comprising delays can vary from relatively productive time spent working in an airport lounge to unproductive time spent waiting to clear security or sitting on the tarmac with laptops and cell phones stowed.

Context-Specific Time Valuation

Exploratory Stated Preference Survey

- ◆ In order to address context-specific time valuation, we have conducted a preliminary study of passenger preferences over different types of delays
 - A survey administered to a sample of convenience: 25 respondents drawn from one consulting firm and two law firms
 - The results indicate support for intuitive notions of context-specific time valuation

Context-Specific Time Valuation

Stated Preference Survey: Example

Assumptions:

Assume that this is an outbound trip (i.e., from home or work to a business destination).

Assume an 8AM departure time.

Assume you are traveling in the coach section of a narrowbody aircraft (e.g., 737).

Alternative

A

B

C

D

Fill In Ranking:

--	--	--	--

1 = least onerous

4 = most onerous

Checkin and Security Clearance Time	60	40	30	25
Airport Terminal Waiting Time	120	20	40	10
Airport Lounge Waiting Time	0	0	0	40
Boarding Time	20	25	15	30
Doors Closed, Laptops Closed Time	250	20	55	50
Laptops Open Time	105	55	95	190
Total Airport to Airport Time				
Minutes	555	160	235	345
Hours	9.25	2.67	3.92	5.75

Context-Specific Time Valuation

Stated Preference Survey Results

Left-Hand Variable is Choice of Trip

Variable		
Checkin and Security Clearance Time	-0.060***	-0.060***
	[0.016]	[0.016]
Airport Terminal Waiting Time	-0.015***	-0.015***
	[0.004]	[0.004]
Airport Lounge Waiting Time	0.001	0.000
	[0.006]	[0.006]
Boarding Time	-0.018	-0.020
	[0.024]	[0.025]
Doors Closed, Laptops Closed Time	-0.015***	-0.015***
	[0.004]	[0.004]
Laptops Open Time	0.0008	
	[0.0029]	
Laptops Open Time x 1st class dummy		-0.0011
		[0.0048]
Laptops Open Time x Coach dummy		0.0042
		[0.0062]
Laptops Open Time x regional jet dummy		0.0005
		[0.0050]
Observations	211	211

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Implications

- ◆ The effective cost of delay depends on the portion of the trip that is lengthened.
- ◆ Transactional airport time (check in, security clearance, etc.) regarded as extremely onerous
- ◆ Many “impaired productivity” portions of the trip mildly onerous (terminal wait time, boarding, laptops/personal items stowed)
- ◆ Settings conducive to productive work (airport lounge, on board “laptops open” time) not regarded as onerous

Implications

- ◆ Cabin setting does not appear to affect results
- ◆ How these findings relate to revealed preference findings on value of time remains unclear
- ◆ Generalizability of this sample of convenience is also unclear