Updating airline cancellation costs and customer disruption

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### Summary of findings

<table>
<thead>
<tr>
<th>Cost per Cancelled Flight Segment (USD 2014)</th>
<th>Controllable Events (e.g. maintenance, crew)</th>
<th>Uncontrollable Events (e.g. weather, airspace)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regional Jets</strong></td>
<td>$2,750 per flight</td>
<td>$1,050 per flight</td>
</tr>
<tr>
<td>Including CRJ, ERJ aircraft</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Legacy Narrowbodies</strong></td>
<td>$15,650 per flight</td>
<td>$4,930 per flight</td>
</tr>
<tr>
<td>Boeing 737 and Airbus 320 families by legacy airlines</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LCC Narrowbodies</strong></td>
<td>$19,240 per flight</td>
<td>$710 per flight</td>
</tr>
<tr>
<td>Boeing 737 and Airbus 320 families by LCC/ULCC airlines</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Small Widebodies</strong></td>
<td>$29,690 per flight</td>
<td>$6,770 per flight</td>
</tr>
<tr>
<td>Boeing 767/787 and Airbus 330 on 8-hr international routes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Large Widebodies</strong></td>
<td>$42,890 per flight</td>
<td>$13,140 per flight</td>
</tr>
<tr>
<td>Boeing 777/747 and Airbus 340 on 12-hr international routes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average Cost</strong></td>
<td>$5,770 average per cancelled flight segment</td>
<td></td>
</tr>
<tr>
<td>Based on weighted average of events across U.S. fleets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Based on masFlight study of flight cancellation costs (supporting data sourced from DOT BTS Form 41, OAG)*
Introduction

Start with two simple questions:

How much does it cost an airline to cancel a flight?
It’s a difficult question to answer, but a relevant metric:
- Airline cost/benefit analysis
- Passenger handling and re-accommodation
- Regulatory policy
Every airline has different input costs and customer policies.
But can we create generalized metrics that are useful?

What is the impact of cancellations on passengers?
- Additional travel time due to extended re-accommodation?
- Differences between business and leisure traffic?
- Differences between LCCs and legacy airlines?
- Have merged networks improved passenger re-accommodation options?
We examine cancellation costs in the U.S. market and focus on what has changed since 2007.

- **Higher Fuel Cost**: $1.84 to $3.00 - savings from not operating flights
- **Higher Load Factors**: From 79% to 83% - few empty seats to re-accommodation
- **Larger Aircraft**: 69 → 82 avg passengers per flight; more per event
- **Limited Interline**: Preference for online re-accommodation
- **Labor Changes**: Higher wages, different ability to reschedule
- **Merged Networks**: More routings possible to recover a/c, crews, pax

Focused on re-active cancellations – not why cancellation decisions occur, just on how much it costs when they do.

More focus on the cancellation *decision* versus cost!

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Cancellation cost</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Airlines (2014)</td>
<td>$1,765 per flight</td>
<td>Announced $60 million cost for 34,000 weather cancellations during 1Q14</td>
</tr>
<tr>
<td>Hansen, Xiong (2009)</td>
<td>$5,517 per flight</td>
<td>Based on equivalent delay minutes (one cancellation = 165.9 delay min) and $30 per minute delay cost</td>
</tr>
<tr>
<td>Metron (2006)</td>
<td>$6,000 per flight</td>
<td>Unpublished NAS performance report – airlines protested as too low</td>
</tr>
<tr>
<td>Shavell (1998)</td>
<td>$16,926 per flight</td>
<td>Based on aggregated airline reports in 1998 to ASQP/DOT of $858 million divided by 74,000 cancelled flights</td>
</tr>
<tr>
<td>Sridar (2007)</td>
<td>$18,000 per flight</td>
<td>Based on equivalent delay minutes (one cancellation = 600 mins) and $30 per minute delay cost</td>
</tr>
</tbody>
</table>

There’s a wide variation – we need to build estimates ground-up
Let’s start with a baseline scenario and build from there:

- **Reactive cancellations** before gate departure
  True cancellations (not 12-24 hour delays)

- When the decision occurs is relevant

- Cost of a cancellation decision (primary & downstream)

Many factors we need to consider for cost estimates:

- Controllable (crew, mx.) vs. uncontrollable (weather, NAS)

- Route profile (short, medium & long-haul)

- Aircraft type (small CRJ through widebody)

- Airline type (regional, major & LCC)
In the United States, carrier-controllable cancellations exhibit low variability (moved significantly only by regulatory changes) while uncontrollable cancellations vary by season and winter severity.

Reported US flight cancellations by month (DOT Part 234)
Cancellations by category

Material differences in cancellation rates by aircraft category, and differences in the reasons as well.

<table>
<thead>
<tr>
<th>Reported Flights</th>
<th>Cancelled as % of Scheduled</th>
<th>Controllable (Carrier)</th>
<th>Uncontrollable (Wx, NAS, TSA)</th>
<th>Cancelled at Diversion Apt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turboprop</td>
<td>2.9%</td>
<td>33.5%</td>
<td>66.5%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Regional jet</td>
<td>2.6%</td>
<td>31.0%</td>
<td>69.0%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Narrowbody</td>
<td>1.0%</td>
<td>41.8%</td>
<td>58.2%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Widebody</td>
<td>1.0%</td>
<td>57.2%</td>
<td>42.8%</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

Source: DOT Part 234 ASQP from reporting carriers, September 2009 through August 2014, domestic flights only. Controllable cancellations coded “A” and uncontrollable cancellations coded “B”, “C” or “D.”
What are relevant costs

<table>
<thead>
<tr>
<th>Incremental costs</th>
<th>Allocable Costs</th>
<th>Cost Offsets</th>
<th>Opportunity costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>(new, out of pocket)</td>
<td>(wasted expenses)</td>
<td>(real benefits)</td>
<td>(forfeit by carrier)</td>
</tr>
</tbody>
</table>

- **Crew** salaries & benefits, per diem awaiting rescheduling, transportation costs, hotel costs – direct and buffers
- **Maintenance** cost to prepare aircraft, labor and materials, allocation of indirect maintenance to that flight
- **Catering and passenger services** including perishable food, catering preparation & loading, bonding, etc.
- **Airport and handling** including above- and below-wing, terminal fees, reservations center
- **Aircraft parking** awaiting new flight
- **Aircraft ownership** (debatable!)

- **Ticket refunds and interline fees** for pax that cancel or re-book on OA (plus merchant fees, GDS fees, etc.)
- **Passenger re-accommodation** incl. hotels, meals, transportation (depends on cancellation causes)
- **Displaced revenue** from accommodating impacted pax and consuming open inventory

- **Offsets:**
  - **Fuel burn** – huge impact
  - **Landing & airport fees**
Ground-up cancellation cost model for five aircraft types based on DOT data and real-world aircraft utilization

1. Five aircraft families/roles modeled (regional jet, mainline narrowbody, LCC narrowbody, small widebody and large widebody)

2. Use DOT Form 41 and OEM costs per hour, aggregated by category (e.g. B737NG/A320/717/MD80 aggregated into single group)

3. Review how airlines schedule the aircraft – average block hours, stage lengths, configurations/loads/yields, staffing and utilization
   - Fare and yield data – use DOT DB1B ticket data
   - Utilization, configuration, etc. – OAG flight schedules for Oct 2014

4. Calculate operating costs for cancelled segments (including offsets for saved expenses) and follow-on impact assuming 1:1 inverse

5. Roll up direct (out-of-pocket), indirect and opportunity costs
Operational impact

We model cancellation decisions that impact two flight segments:
Only the first segment cancelled is re-active – the follow-on is pro-active

**Option 1**
Aircraft cancels at spoke airport

**Option 2**
Aircraft cancels at hub airport

**Option 3**
Aircraft cancels during multi-stop routing
Keep it simple – rough order of magnitude cost once a decision to cancel has been made

**Average costs** across aircraft groups – grouping labor contracts, aircraft vintages, maintenance programs, etc.

**The resulting cost model** is a foundation to customize unique labor, aircraft, crew contracts and customer service standards for each airline.
<table>
<thead>
<tr>
<th>Region</th>
<th>Stage Length</th>
<th>Seats</th>
<th>Aircraft</th>
<th>Traffic Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regional Jets</strong></td>
<td>1.6 hr</td>
<td>50 seats (All Y)</td>
<td>CRJ/ERJ</td>
<td>Business/leisure mix</td>
</tr>
<tr>
<td><strong>Narrowbody - Legacy</strong></td>
<td>2.5 hr</td>
<td>150 seats (8F/142Y)</td>
<td>737/320</td>
<td>Business/leisure mix</td>
</tr>
<tr>
<td><strong>Narrowbody - LCC</strong></td>
<td>2.5 hr</td>
<td>168 seats (All Y)</td>
<td>737/320</td>
<td>Leisure traffic</td>
</tr>
<tr>
<td><strong>Widebody – Med-Haul</strong></td>
<td>8 hr</td>
<td>240 seats (40C/220Y)</td>
<td>767/787/330</td>
<td>Business/leisure mix</td>
</tr>
<tr>
<td><strong>Widebody – Long-Haul</strong></td>
<td>12 hr</td>
<td>280 seats (56C/224Y)</td>
<td>777/747</td>
<td>Business/leisure mix</td>
</tr>
</tbody>
</table>

Average stage lengths from OAG (October 2014) by aircraft grouping
## Inputs: DOT Form 41

<table>
<thead>
<tr>
<th></th>
<th>Regional Jet Families</th>
<th>Narrowbody Families</th>
<th>Small Widebodies</th>
<th>Large Widebodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft ownership</td>
<td>$380</td>
<td>$630</td>
<td>$790</td>
<td>$1,070</td>
</tr>
<tr>
<td>Crew</td>
<td>$380</td>
<td>$680</td>
<td>$1,010</td>
<td>$1,240</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$540</td>
<td>$790</td>
<td>$1,140</td>
<td>$1,600</td>
</tr>
<tr>
<td>Direct cost</td>
<td>$370</td>
<td>$610</td>
<td>$830</td>
<td>$1,160</td>
</tr>
<tr>
<td>Indirect cost</td>
<td>$160</td>
<td>$190</td>
<td>$310</td>
<td>$440</td>
</tr>
<tr>
<td>Fuel expense ($)</td>
<td>$1,370</td>
<td>$2,690</td>
<td>$4,990</td>
<td>$7,620</td>
</tr>
<tr>
<td>Fuel gallons/hour</td>
<td>460 gals/hr</td>
<td>910 gals/hr</td>
<td>1,690 gals/hr</td>
<td>2,550 gals/hr</td>
</tr>
<tr>
<td>Direct Operating Cost/Hr</td>
<td>$2,670</td>
<td>$4,790</td>
<td>$7,930</td>
<td>$11,530</td>
</tr>
</tbody>
</table>

**Sourced from DOT Form 41 Schedule P-5.2 Reports for 2Q14 (bts.gov)**

Total direct operating costs divided by airborne hours

*Regional jets* include Embraer and Bombardier CRJ/ERJ families (fuel cost based on gal/hr)
*Narrowbody families* include Boeing 737, Airbus 319/320/321 and McDonnell-Douglas 717/MD80/90
*Small widebodies* include Airbus A330, Boeing 767 and Boeing 787 families
*Large widebodies* include Boeing 777 and 747 families
How often airlines fly a route (and with what equipment) is relevant for operational recovery (aircraft positioning) and passenger re-accommodation in empty seats.

<table>
<thead>
<tr>
<th>Daily flights by route by aircraft type scheduled</th>
<th>Specific Equipment on Route</th>
<th>All Equipment on Route</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily Flights</td>
<td>Daily Seats</td>
</tr>
<tr>
<td>Regional Jets</td>
<td>2.9 flights</td>
<td>176 seats</td>
</tr>
<tr>
<td>Narrowbodies</td>
<td>2.4 flights</td>
<td>344 seats</td>
</tr>
<tr>
<td>Small Widebodies</td>
<td>1.1 flights</td>
<td>257 seats</td>
</tr>
<tr>
<td>Large Widebodies</td>
<td>1.1 flights</td>
<td>320 seats</td>
</tr>
</tbody>
</table>

Source: OAG Schedules for week ending October 7, 2014 for US-domiciled carriers

Regional jets include 100/200/700/705/900, ERJ includes 135/140/145, EMJ includes 170/175/190
Narrowbodies include 737 classic and NG families, A319/320/321, and MD-80/90/717 families
Small widebodies include A330, B767, B787; large widebodies include B777, B747, A340
Reactive cancellation = crew has reported for duty or is extremely unlikely to be reassigned to alternate flying within duty window

We interviewed airlines and reviewed labor contracts – most have right to reassign crews, but rarely happens with limited-scale cancellation events

- DOT Reported pilot cost per flight hour by aircraft type
- Add cabin crew based on staffing and $30-$60 hourly wages
- Add augmentation for short-haul and long-haul international flights
- Add buffer for duty time and transportation
- Assume one crew for every two cancelled flights must overnight (hotel + per diem provided for each cancelled crewmember)

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>Regional Jet</th>
<th>Narrowbody</th>
<th>Small WB</th>
<th>Large WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route type</td>
<td>Express</td>
<td>Mainline</td>
<td>LCC</td>
<td>Short Int'l</td>
</tr>
<tr>
<td>Crew pay per event</td>
<td>$820</td>
<td>$2,330</td>
<td>$2,410</td>
<td>$16,760</td>
</tr>
<tr>
<td>Lodging/per diem</td>
<td>$450</td>
<td>$1,200</td>
<td>$1,050</td>
<td>$3,410</td>
</tr>
</tbody>
</table>
Model: Maintenance

Reactive cancellation = time-limited aircraft maintenance performed (ETOPS, daily, etc.) but substantial variable cost is avoided as well

- Start with Form 41 labor and materials cost per flight hour by aircraft type
- Isolate direct (variable, flight-hour based) and indirect + burden components
- Allocate 25% of direct maintenance cost per flight hour to the cancelled flight
- Allocate 75% of indirect maintenance cost to the cancelled flight
- Why 25/75? Significant savings from not operating the flight segment, but there’s still real cost related to direct expenses and fixed/amortization

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>RJs</th>
<th>Narrowbody</th>
<th>Small WB</th>
<th>Large WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route type</td>
<td>Express</td>
<td>Mainline</td>
<td>LCC</td>
<td>Short Int’l</td>
</tr>
<tr>
<td>Direct CPH, allocated</td>
<td>$90</td>
<td>$150</td>
<td>$150</td>
<td>$250</td>
</tr>
<tr>
<td>Indirect CPH, allocated</td>
<td>$120</td>
<td>$140</td>
<td>$140</td>
<td>$250</td>
</tr>
<tr>
<td>Average stage length</td>
<td>97 min</td>
<td>150 min</td>
<td>150 min</td>
<td>480 min</td>
</tr>
<tr>
<td>Mx cost per cancellation</td>
<td>$350</td>
<td>$730</td>
<td>$730</td>
<td>$3,970</td>
</tr>
</tbody>
</table>
# Model: Airport-related

**Airport-related services already performed at time of cancellation**

- Catering and aircraft servicing – contracted and delivered (or non-cancellable)
- Airport-related variable costs and reservations/customer service (check-in, baggage check and re-claim, gate/hold area usage, etc.)
- Above-wing and below-wing servicing expense and related overtime
- Aircraft parking awaiting next departure (based on next scheduled departure)

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>RJs</th>
<th>Narrowbody</th>
<th>Small WB</th>
<th>Large WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route type</td>
<td>Express</td>
<td>Mainline</td>
<td>LCC</td>
<td>Short Int’l</td>
</tr>
<tr>
<td>Catering/pax, Y cabin</td>
<td>$0.50</td>
<td>$0.50</td>
<td>$0.25</td>
<td>$15</td>
</tr>
<tr>
<td>Catering/pax, F/C cabins</td>
<td>N/A</td>
<td>$15</td>
<td>N/A</td>
<td>$40</td>
</tr>
<tr>
<td>Total catering &amp; services</td>
<td>$70</td>
<td>$280</td>
<td>$90</td>
<td>$4,920</td>
</tr>
<tr>
<td>Airport-related costs</td>
<td>$400</td>
<td>$1,220</td>
<td>$1,480</td>
<td>$1,980</td>
</tr>
<tr>
<td>Staffing &amp; overtime</td>
<td>$120</td>
<td>$360</td>
<td>$440</td>
<td>$590</td>
</tr>
<tr>
<td>Airport parking</td>
<td>$90</td>
<td>$140</td>
<td>$140</td>
<td>$1,260</td>
</tr>
<tr>
<td>Catering/station per flight</td>
<td>$680</td>
<td>$2,010</td>
<td>$2,150</td>
<td>$8,750</td>
</tr>
</tbody>
</table>
Reactive cancellation = savings from not flying (maintenance, fuel, landing and navigation/overflight fees)

- Fuel matters a lot at $3.00 per gallon
- We account for maintenance savings earlier
- Assumed landing fees of $2 per thousand MTOW
- Assumed navigation fees of $1,000/$3,000 for small/large widebodies

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>RJs</th>
<th>Narrowbody</th>
<th>Small WB</th>
<th>Large WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route type</td>
<td>Express</td>
<td>Mainline</td>
<td>LCC</td>
<td>Short Int’l</td>
</tr>
<tr>
<td>Fuel burn per block hour</td>
<td>440</td>
<td>866</td>
<td>875</td>
<td>1,609</td>
</tr>
<tr>
<td>Fuel cost per trip ($3/gal)</td>
<td>$2,130</td>
<td>$6,490</td>
<td>$6,560</td>
<td>$38,610</td>
</tr>
<tr>
<td>Landing fees</td>
<td>$110</td>
<td>$350</td>
<td>$350</td>
<td>$1,070</td>
</tr>
<tr>
<td>Overflight fees</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>$1,000</td>
</tr>
<tr>
<td><strong>Total offsets</strong></td>
<td><strong>$2,240</strong></td>
<td><strong>$6,840</strong></td>
<td><strong>$6,910</strong></td>
<td><strong>$40,680</strong></td>
</tr>
</tbody>
</table>

Sources: Form 41 (Fuel Burn per Hour) adjusted 95% FH/BH, 2Q14 fuel expense per gallon; landing fees based on airport average of PANYNJ 2014; overflight fees estimated based on masFlight routing data
What’s important for commercial costs related to cancellations?

- Controllable/uncontrollable – what customer service obligations?
- Ticket refunds – cash out-of-pocket and associated transaction fees?
- Empty seats – time to re-accommodate, and revenue displaced?

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>RJs</th>
<th>Narrowbody</th>
<th>Small WB</th>
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</thead>
<tbody>
<tr>
<td><strong>Route type</strong></td>
<td>Express</td>
<td>Mainline</td>
<td>LCC</td>
<td>Short Int’l</td>
</tr>
<tr>
<td>Configuration</td>
<td>50Y</td>
<td>8F/142Y</td>
<td>168Y</td>
<td>40C/200Y</td>
</tr>
<tr>
<td>Premium Load Factor</td>
<td>N/A</td>
<td>95%</td>
<td>N/A</td>
<td>95%</td>
</tr>
<tr>
<td>Premium Passengers</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>Economy Load Factor</td>
<td>80%</td>
<td>80%</td>
<td>88%</td>
<td>80%</td>
</tr>
<tr>
<td>Economy Passengers</td>
<td>40</td>
<td>122</td>
<td>148</td>
<td>160</td>
</tr>
<tr>
<td>Blended Load Factor</td>
<td>80%</td>
<td>81%</td>
<td>88%</td>
<td>83%</td>
</tr>
<tr>
<td><strong>Empty Seats per Flight</strong></td>
<td><strong>10</strong></td>
<td><strong>20</strong></td>
<td><strong>20</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

Sources: configurations based on OAG schedules by aircraft category, October 2014; load factors based on domestic T-100 enplanement data for 2013.
Refund considerations include:

- What percent on business vs. leisure (business refund rate higher)
- What percent away from home (assume they don’t refund)
- What fare they paid (O&D fare matters, not segment fare)
- Transaction fees (credit card refund, GDS, loyalty points/goodwill)

Average Fare Paid (Based on DB1B Domestic Yields)

Source: DOT DB1B 2Q13-1Q14 Yields
Model: Displaced passengers

What’s important for commercial costs related to cancellations?

- Controllable/uncontrollable – what customer service obligations?
- Ticket refunds – cash out of pocket and associated transaction fees?
- Empty seats – time to re-accommodate, and revenue displaced?

![Diagram showing the flow of passengers and costs](image-url)
**Model: Refunds**

Refund rate is based on originating passengers only, and differential refund rates for business (or business-like) and economy passengers:

- Assume 50/50 split of O&D traffic
- Originating passengers – 30% of business and 20% of leisure get refund
- En-route passengers – all seek re-protection + hotel/OA options
- 6% transaction fees (credit card, agency/GDS and frequent flyer incentives)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Route type</td>
<td>Express</td>
<td>Mainline</td>
<td>LCC</td>
<td>Short Int’l</td>
</tr>
<tr>
<td>Average net premium fare</td>
<td>N/A</td>
<td>$827</td>
<td>N/A</td>
<td>$834</td>
</tr>
<tr>
<td>Average net economy fare</td>
<td>$168</td>
<td>$189</td>
<td>$150</td>
<td>$339</td>
</tr>
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<td>Refunds + fees processed</td>
<td>$1,070</td>
<td>$5,440</td>
<td>$2,700</td>
<td>$13,380</td>
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</table>
For controllable cancellations – and some uncontrollable events, in each airline’s discretion – hotel and meal costs apply

- Calculate available seats within next 24 and 48 hour windows
- Apply estimated load factors (route averages) to calculate available seats
- Allocate passengers to flights – count how many taken next 24, 48 hrs
- Assume that 75% of re-accommodated passengers need hotel rooms

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>RJs</th>
<th>Narrowbody</th>
<th>Small WB</th>
<th>Large WB</th>
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<td>Long Int’l</td>
<td></td>
<td></td>
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<tr>
<td>Re-protected passengers</td>
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<td>100</td>
<td>131</td>
<td>140</td>
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<tr>
<td>Re-accommodated w/in 24h</td>
<td>34</td>
<td>75</td>
<td>48</td>
<td>85</td>
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<tr>
<td>Re-accommodated w/in 48h</td>
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<td>25</td>
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<td>55</td>
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<tr>
<td>Per diem and incidentals</td>
<td>$430</td>
<td>$1,950</td>
<td>$3,900</td>
<td>$3,280</td>
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<tr>
<td>Hotel rooms</td>
<td>$1,280</td>
<td>$8,780</td>
<td>$14,630</td>
<td>$19,650</td>
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</table>
In high load factor environment, inventory consumption from passenger re-accommodation is a material consideration

- Small number of high yield booking opportunities are lost
- Less relevant for LCCs and highly relevant for transatlantic routes with last-minute business bookings in premium cabins
Model: Revenue spill

Extended re-accommodation times → future bookings are displaced by rebooked passengers and blocked inventory

- Calculate occupied seats within next 48 hours (blocked inventory matters)
- Estimate last-minute (within 72 hours) revenue across categories
- Incorporate savings from processing fees, etc. – net revenue matters

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>RJs</th>
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<th>Small WB</th>
<th>Large WB</th>
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<tbody>
<tr>
<td>Route type</td>
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<td>Economy seats occupied</td>
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<td>Displaced economy revenue</td>
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<td>$3,670</td>
<td>$1,970</td>
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<td>Offset taxes and processing</td>
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<td>($550)</td>
<td>($300)</td>
<td>($1,880)</td>
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<td>Net displaced revenue</td>
<td>$490</td>
<td>$3,120</td>
<td>$1,670</td>
<td>$10,620</td>
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What about the follow-on flight segment?

- It’s a **proactive** cancellation (advance decision) versus reactive
- Some cost items are avoided (crew accommodation, catering, airport handling, etc.) since the airline has time to notify vendors, re-plan
- If it’s an uncontrollable cancellation where the airline isn’t liable (or chooses not to pay) then the offsets in the second segment can exceed the out of pocket cost – net result, savings from not flying
- In the model, each cancellation **decision = two flight segments** so we want the average of first and second impacted segments.
## Summary: Controllable events

For controllables, segment cost from $2,750 to $43,000

<table>
<thead>
<tr>
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<th>Regional Jets</th>
<th>Legacy Narrow</th>
<th>LCC Narrow</th>
<th>Med-Haul Widebody</th>
<th>Long-Haul Widebody</th>
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<tr>
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<td>6,350</td>
<td>32,900</td>
<td>61,600</td>
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<tr>
<td>Net offsets (fuel, landing fees)</td>
<td>(2,240)</td>
<td>(6,840)</td>
<td>(6,910)</td>
<td>(40,680)</td>
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<td>Total operating cost impact</td>
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<td>43,560</td>
<td>83,520</td>
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<td><strong>Cancellation cost, cancelled segment</strong></td>
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<td>$17,250</td>
<td>$20,840</td>
<td>$35,770</td>
<td>$53,610</td>
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</table>

| **Follow-on segment cancellation** |               |               |            |                   |                    |
| Follow-on segment incremental cost | 1,170         | 3,060         | 3,140      | 20,730            | 40,150             |
| Follow-on segment offsets          | (2,240)       | (6,840)       | (6,910)    | (40,680)          | (91,510)           |
| Commercial/revenue, follow-on      | 3,260         | 17,830        | 21,400     | 43,560            | 83,520             |
| **Cancellation cost, follow-on segment** | $2,180 | $14,050       | $17,630    | $23,610           | $32,160            |

| Total direct cancellation cost      | $5,500         | $31,300       | $38,470    | $59,380           | $85,770            |
| Average cost per flight segment     | $2,750         | $15,650       | $19,240    | $29,690           | $42,890            |
Summary: Uncontrollable events

For uncontrollables, segment cost from $710 to $13,140
Primary difference is passenger re-accommodation

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<th>Med-Haul Widebody</th>
<th>Long-Haul Widebody</th>
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<tr>
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<td>Total operating cost impact</td>
<td>60</td>
<td>(580)</td>
<td>(570)</td>
<td>(7,790)</td>
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<tr>
<td>Commercial/revenue cost</td>
<td>1,560</td>
<td>7,110</td>
<td>2,880</td>
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<td>53,770</td>
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<td><strong>Cancellation cost, cancelled segment</strong></td>
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<td>$23,860</td>
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|                        |               |               |            |                   |                    |
| **Follow-on segment cancellation** |           |               |            |                   |                    |
| Follow-on segment incremental cost | 1,170     | 3,060         | 3,140      | 20,730            | 40,150             |
| Follow-on segment offsets | (2,240)     | (6,840)       | (6,910)    | (40,680)          | (91,510)           |
| Commercial/revenue, follow-on | 1,560       | 7,110         | 2,880      | 20,630            | 53,770             |
| **Cancellation cost, follow-on segment** | $480       | $3,320        | (890)      | $680              | $2,410             |

| Direct cancellation cost | $2,100 | $9,850 | $1,420 | $13,530 | $26,270 |
| Average cost per flight segment | $1,050 | $4,930 | $710  | $6,770  | $13,140 |
Summary: Cost per segment

**Cost of a cancelled flight segment**

- **Long-Haul WB**: $13,140
- **Med-Haul WB**: $6,770
- **LCC Narrow**: $710
- **Legacy Narrow**: $4,930
- **Regional Jet**: $1,050

**Uncontrollable Events**

- **Long-Haul WB**: $42,890
- **Med-Haul WB**: $29,690
- **LCC Narrow**: $19,240
- **Legacy Narrow**: $15,650
- **Regional Jet**: $2,750

**Controllable Events**

- **Sridar (2007)**: $18,000
- **Shavell (1998)**: $16,920
- **Metron (2006)**: $6,000
- **Our findings (weighted avg)**: $5,770
- **Hansen (2009)**: $5,520
- **American Airlines**: $1,760

*Weighted average is based on controllable and uncontrollable cancellation counts from Part 234, 2009-2014*
Summary: what’s important

- **Wide variation** between RJs and widebodies, business models
  - LCCs – leisure booking curves, low fares mean revenue displacement and commercial costs are lower than full-service
  - The more business/premium customers on the aircraft, the more commercial and operational exposure the cancellation brings
- **Fuel cost per gallon** – because fuel is a primary offset, higher fuel prices mean cancellations are “cheaper”
- **Load factors** – passenger re-accommodation takes longer, particularly for low-cost carriers. Strong encouragement to delay versus cancel
- **Top-down academic studies** were in the ballpark based on reported airline results – and our findings align with AA’s 1Q14 metrics
- **Our model** creates a foundation for thinking about cost, benefits

Finally, let’s look at the customer’s perspective.
Increased routing opportunities

Pre-Merger Route Networks

Delta Air Lines Mainline
Northwest Mainline
United Mainline
Continental Mainline
## Boston (BOS)-San Diego (SAN) 1/28/2008 – Pre-merger UA and CO

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<th>Flights</th>
<th>Equip</th>
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**CO over EWR/IAH; UA over ORD/IAD/DEN/SFO/LAX**
Example: Post-merger UA BOS-SAN

Boston (BOS)-San Diego (SAN) 1/27/2014 – Rationalized UA/CO

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<td>DEN</td>
<td>4</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>EWR</td>
<td></td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>IAH</td>
<td></td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>LAX</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>ORD</td>
<td></td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>SFO</td>
<td></td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>11</td>
<td>24</td>
</tr>
</tbody>
</table>

Available routings BOS-XXX-SAN (masFlight/OAG)
**Can we measure** the positive impact of mergers on available routings (It’s about the scope of routings offered to the customer)

**Rationalization** eliminates duplicative frequencies over redundant hubs (Hub closures such as CLE, CVG, MEM - not all O&D pairs benefit!)

**Reviewed** the top 500 O&D markets in the United States (YE 1Q14) and measured the change in offered routings (nonstop/one-stop) 2008 vs 2014

<table>
<thead>
<tr>
<th>Post-merger network</th>
<th>United</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>City pairs with service from 2008 through 2014</td>
<td>1,282</td>
<td>1,375</td>
</tr>
<tr>
<td>Routings increased from 2008 to 2014</td>
<td>865</td>
<td>959</td>
</tr>
<tr>
<td>Routings equal or decrease from 2008 to 2014</td>
<td>417</td>
<td>416</td>
</tr>
<tr>
<td>50% or more routings increase</td>
<td>545</td>
<td>461</td>
</tr>
<tr>
<td>50% or more routings decrease</td>
<td>32</td>
<td>27</td>
</tr>
</tbody>
</table>

*masFlight/OAG review of flight schedules and routings 2008-2014
Routings are discrete itinerary options from origin to destination city, incl. nonstops and one-stop connections*
Final thoughts

How much does it cost an airline to cancel a flight?
• Up to $40K, but on average $6K. It used to cost more, but fuel offsets.
• LCCs have different risks than legacies with business traffic

Can a single cancellation metric apply on industry-wide scale?
• No – the differences between controllable and uncontrollable, small regional jets versus long-haul widebodies drive extreme variation.

Is this finding different from prior academic studies?
• No – but the mean is deceptive when applied to airline decision making.

Have mergers helped passenger re-accommodation?
• Number of routings between major city pairs has gone up.
• Some losers – particularly around closed hubs, rationalized routes
• Many winners – cities w/multiple airports, new hub-to-hub connections
• Mitigates negative impact from higher load factors and fewer seats
## Appendix – Modeled Aircraft

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Regional Jet</th>
<th>Typical Narrowbody</th>
<th>Small WB</th>
<th>Large WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage length (mi)</td>
<td>400</td>
<td>900</td>
<td>900</td>
<td>3,600</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,000</td>
</tr>
<tr>
<td>Block hours</td>
<td>1.6</td>
<td>2.5</td>
<td>2.5</td>
<td>8.0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.0</td>
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<tr>
<td>Seating by cabin</td>
<td>50Y</td>
<td>8F/142Y</td>
<td>168Y</td>
<td>40C/200Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>56C/224Y</td>
</tr>
<tr>
<td>Average Y fare</td>
<td>$168</td>
<td>$189</td>
<td>$150</td>
<td>$339</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$550</td>
</tr>
<tr>
<td>Y Load Factor</td>
<td>80%</td>
<td>80%</td>
<td>88%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>80%</td>
</tr>
<tr>
<td>Average C fare</td>
<td>N/A</td>
<td>$827</td>
<td>N/A</td>
<td>$834</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$2,000</td>
</tr>
<tr>
<td>C Load Factor</td>
<td>N/A</td>
<td>95%</td>
<td>N/A</td>
<td>95%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>95%</td>
</tr>
<tr>
<td>Fuel gal per hr</td>
<td>440</td>
<td>866</td>
<td>875</td>
<td>1,609</td>
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<td></td>
<td></td>
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<td>2,422</td>
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<tr>
<td>Flight deck per hr</td>
<td>$376</td>
<td>$684</td>
<td>$684</td>
<td>$1,012</td>
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<td></td>
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<td></td>
<td></td>
<td>$1,238</td>
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<tr>
<td>Cabin crew per hr</td>
<td>$30</td>
<td>$91</td>
<td>$120</td>
<td>$600</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>$720</td>
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<tr>
<td>Mx cost per hr</td>
<td>$537</td>
<td>$793</td>
<td>$793</td>
<td>$1,141</td>
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<td></td>
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<td></td>
<td></td>
<td>$1,602</td>
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<tr>
<td>Aircraft MTOW</td>
<td>53K</td>
<td>174K</td>
<td>174K</td>
<td>534K</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>656K</td>
</tr>
</tbody>
</table>
Appendix - Sources


Sridar. *Relationship between weather, traffic and delay based on empirical methods*. NEXTOR 2007

Cramer and Irrgang, *Disruption Costing Methodology*. AGIFORS 2007

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