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QSI Fundamentals

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Agenda

- QSI Fundamentals
- QSI Values
- QSI Share Calculations
- QSI Forecasts
- QSI Adjustments

Many of you have heard the term QSI model – right?

What does QSI stand for??

QSI fundamentals

What exactly is QSI???

- QSI stands for “Quality of Service Index”
- QSI is a method to make qualitative analyses more quantitative
- QSI assigns relative values to the likelihood of consumer behavior options
- Airlines use QSI analyses extensively to predict passenger behavior
- QSI theory goes that when choosing among schedule options:
  - Passengers prefer non-stop itineraries over connections
  - Passengers prefer larger aircraft over smaller aircraft
- QSI theory generally assumes “all other things being equal”
- QSI “models” exist to help people perform complex QSI analyses

QSI fundamentals

Does QSI theory actually work??

- Let's take a survey…
- How many of you flew to PBI on non-stop flights?
- How many of you flew to PBI on connecting flights?
  - How many of you connectors had non-stop options?
- How many of you flew on turboprops?
  - How many of you connectors had other options?

QSI fundamentals

How do airlines use QSI analyses?

- Airlines try to predict which Schedule itineraries passengers will choose
- QSI can help airlines predict market shares using the concept of “fair share”
  - Airline sales teams use fair shares to determine sales targets and incentives
  - “Share Gap” analyses compare performance to fair shares
  - Airline route planners use QSI models to forecast performance of new flights
- QSI analyses help an airline answer questions about routes like:
  - Load Factor—How many passengers will board the flight?
  - Origin and Destination—Will the passengers be “local” or “connecting”?
  - Revenue—How much will these passengers pay?
  - Cannibalization—Are the passengers new to the airline?

QSI fundamentals

How would an airport use QSI analyses?

- Is there anyone here that DOES NOT want more passengers and flights at your airport?
- You can analyze a proposed flight's passenger composition
  - Identify new route opportunities for airline meetings
  - Justify the validity of your business case just like the airline would
- QSI analyses would also help an ***airport*** answer questions like:
  - Load Factor—How many passengers will board the flight?
  - Origin and Destination—Will the passengers be "local" or "connecting"?
  - Revenue—How much will these passengers pay?
  - Cannibalization—Are the passengers new to the airline?
- Merely stating "thousands live / vacation here" isn't going to get it done!

QSI fundamentals

What are the steps involved with using QSI to evaluate new flights??

1. Determine the factors that passengers value when choosing flights
   - Typical QSI analyses use number of stops and aircraft type
   - Passengers prefer schedule options with less stops and bigger aircraft
2. Assign QSI values or coefficients to the different possibilities for each factor
3. Calculate the QSI shares for each possibility in a scenario
4. Add a new (set of) flight(s) to the scenario and forecast shares using QSI
5. Adjust the QSI forecast results to account for “all other things being equal”

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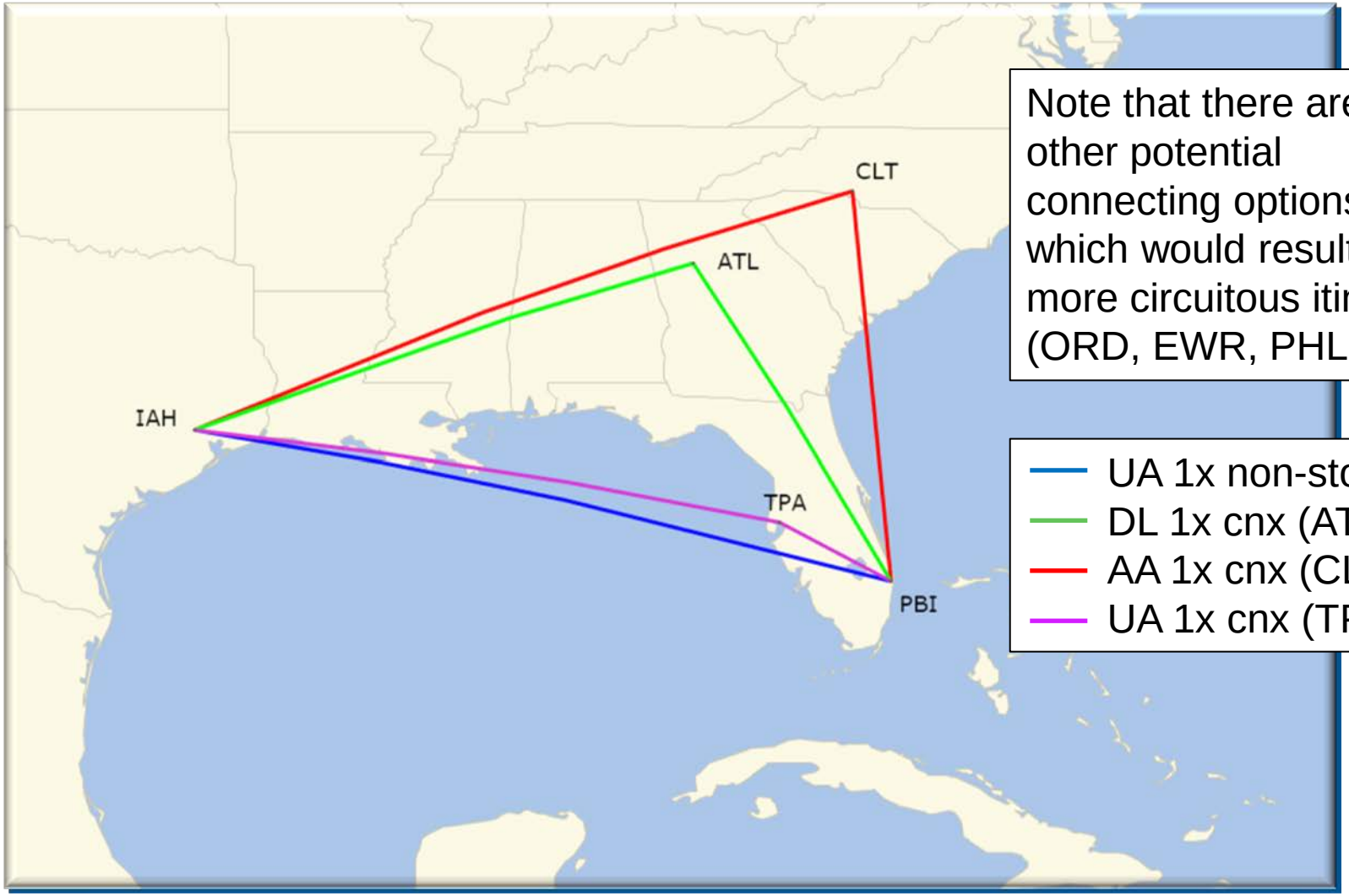
QSI values

QSI analyses assign coefficients to key consumer choice factors

- The underlying principle of QSI analyses is to quantify the qualitative
- Airline passengers base their schedule decisions on such factors as:
  - Connectivity—non-stop, single-connect, double-connect, interline?
  - Aircraft type—turboprop, RJ, narrow body, mid body, wide body?
  - Frequency—weekly, day of week, daily, 3 x daily, shuttle?
  - Travel time—non-stop, en route connection, backhaul?
  - Time of day—pre-dawn, morning, noon, after meetings?
  - Day of week—Sunday conference reception, Mon-Thu, weekend getaway?
  - Frequent flyer program?
- Analysts look at historical data to observe behavior

QSI values

How would you rank the options to fly here to PBI from IAH on Monday?



Note that there are other potential connecting options, which would result in a more circuitous itinerary (ORD, EWR, PHL, etc.)

- UA 1x non-stop
- DL 1x cnx (ATL)
- AA 1x cnx (CLT)
- UA 1x cnx (TPA)

QSI values

Determining the relative values for QSI factors is its own analysis

- For this discussion, we'll use default values from a commonly used tool
- The "Non-stop Narrow Body" forms the basis of the other values: 1.0
- All other values are derived from comparative likelihood in historical data

	Wide Body	Mid Body	Narrow Body	Regional	Turboprop
Non-stop	2.0	1.5	1.0	0.66	0.35
One-stop	0.40	0.30	0.20	0.10	0.08

	Jet - Jet	Jet - Turbo/RJ	Turbo/RJ - Turbo/RJ
Online Single	0.05	0.04	0.03
Interline Single	0.005	0.004	0.003

	Jet	Turbo/RJ
Online Double	0.002	0.001
Interline Double	0.0003	0.00015

QSI values

So how do the various Monday options for IAH rate relatively?

- Look up the QSI values for each itinerary on the previous chart

Airline	Stops	Aircraft	QSI Value
UA	-	RJ	0.66
DL	ATL	RJ-Narrow	0.04
AA	CLT	Narrow-Narrow	0.05
UA	TPA	Narrow-Prop	0.04

- What units do the QSI values represent?
  - QSI values do not have units, they are just coefficients
  - They only have meaning in relation to each other

QSI values

Wasn't assigning the QSI values pretty easy?

- Yes, but we actually ignored some potential IAH-PBI itineraries
  - Many backhaul itineraries exist over other hubs
  - The number of interline possibilities is also quite substantial
- "Tedious" would describe the task of counting all the schedule possibilities
  - History shows that 95% of travelers take non-stop or single-connect routings
  - Thankfully, computers are our friends, and QSI models handle the remainder

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QSI share calculations

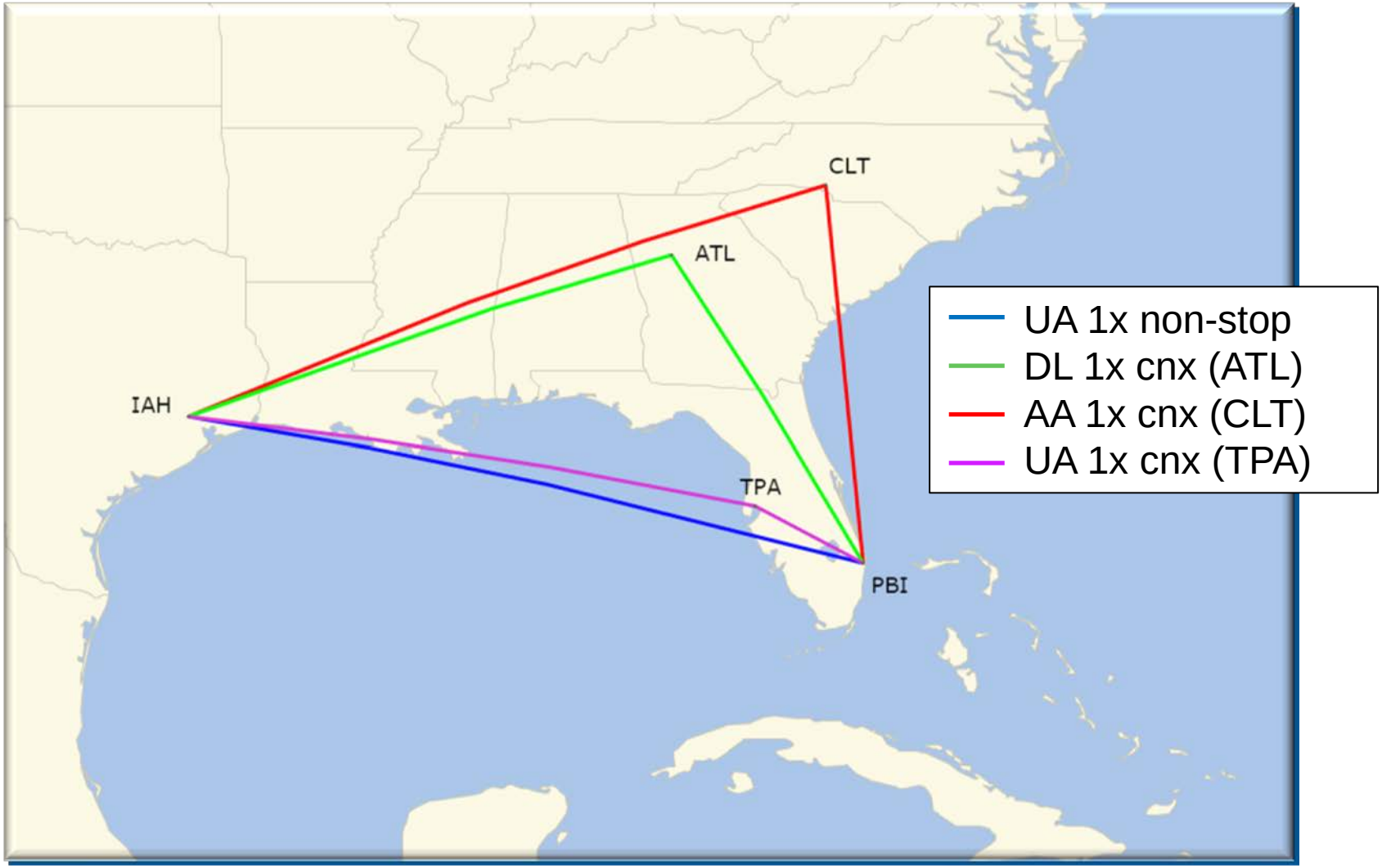
How do we go from assigning QSI values to calculating QSI share you ask??

- The coefficients allow us to compare the factors as part of the whole
- Again, the QSI values themselves have no units
- We established the QSI values to be meaningful in relation to each other
- So if a route has two flights, one wide body and one narrow body:

Aircraft	Value	Share
Wide	2.00	67%
Narrow	1.00	33%
Total	3.00	100%

QSI share calculations

How would you calculate shares for IAH-PBI on Monday?



QSI share calculations

The same QSI values apply to this analysis

- For this discussion, we'll use default values from a commonly used tool
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- All other values are derived from comparative likelihood in historical data

	Wide Body	Mid Body	Narrow Body	Regional	Turboprop
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	Jet	Turbo/RJ
Online Double	0.002	0.001
Interline Double	0.0003	0.00015

QSI Share Calculations

So how do the various Sunday options for IAH rate relatively speaking?

1. Look up the QSI values for each itinerary on the previous chart
2. Account for frequency by simply multiplying by the QSI value
3. Add up totals by airline to get the total QSI for the route
4. Calculate QSI shares by comparing the airline total to the total QSI

Airline	Stops	Aircraft	QSI Value	Share
UA	-	RJ	0.66	84%
DL	ATL	RJ-Narrow	0.04	5%
AA	CLT	Narrow-Narrow	0.05	6%
UA	TPA	Narrow-Prop	0.04	5%
Total			0.79	100%

- Did we account everything here in the QSI total?
  - Backhaul itineraries are probably not realistic options
  - Need another decimal place to include interline and double-connect itineraries

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QSI forecasts

How do we go from QSI market shares to QSI route forecasts?

- Schedule data help us look at the options available to passengers
- In order to forecast the passengers on a route, we also need traffic data
- Possible data sources, covered in earlier presentations, include:
  - U.S. DOT Origin and Destination (DB1B) data
  - Ticketing (ARC/IATA) or Booking (MIDT) data
  - These sources usually also come with fare data
- We already know the fair shares for each possible schedule option
- Traffic data tells us how many passengers want to travel from AAA to BBB
- We therefore allocate passengers to itineraries based on their fair shares

QSI forecasts

Let's say we want to approach UA about new PBI-ORD service

- This map represents UA's ORD schedule for June 2016 – 165 destinations
- Connections to South / Central America are circuitous and unlikely in this scenario

QSI forecasts

Are we tackling the same problem as before, calculating QSI shares?

- We need to calculate UA's fair share of the PBI-ORD local market
- What about the remaining 165 connect points beyond ORD?

QSI forecasts

How do we go from itinerary share calculations to segment forecasts?

- For QSI share, we analyzed flying from A to C with potential connections B
  - Specifically, we looked at IAH-PBI, connecting over ATL, TPA, and CLT
- For a new route, we look at A to B, but also consider potential destinations C
  - The actual flight segment itself is called the “local” market
  - The potential destinations C are called “beyond” points
  - Theoretically, there are “behind” points as well, especially if A is also a hub
- So we have to calculate QSI shares for each of 17 potential itineraries

QSI forecasts

While the forecast is really just a lot of math, it's the same problem each time

- QSI models are set up to iteratively:
  1. Determine legitimate connecting itineraries on either end of the new flight
  2. Calculate the QSI values for each potential legitimate itinerary
  3. Calculate the QSI shares of each new itinerary compared to existing routes
  4. Allocate passengers to each new itinerary based on traffic data and fair share
- Analysts need to provide at least a few inputs into the QSI model
  1. Industry schedules, on which the QSI fair shares will be based
  2. Industry traffic and fare data, on which the pax and rev data will be based
  3. And, of course, the details of the new flight(s)

QSI forecasts

So how do we forecast PBI-ORD on UA?

- To forecast the new route, we selected these options as the main inputs:

1. Schedule: Summer 2016, which gives UA reasonable lead time to add the flight
2. Market Size: the most recent U.S. DOT data file, for the Year-Ending Q2 2015
3. Flight Schedule: based on UA's existing ORD-MIA flights, daily:

Airline	Orig	Dest	Aircraft	Seats	Dep	Arr
UA	ORD	PBI	737-800	118	0730	1136
UA	PBI	ORD	737-800	118	1224	1447

- We also selected these options in the QSI forecasting tool:

1. Online connection windows from 30 minutes to 4 hours
2. "Medium" circuity to allow slight backhauls to the U.S. Midwest

QSI forecasts

Before looking at the results, which connections do we expect to see?

- Schedule-wise, these are 174's northbound connections within four hours

Hub Time	Dest	Arr Time	Flight	Equip	Seats
1519	CVG	1736	3605	CR7	70
1520	ATL	1823	5758	E7W	76
1522	DAY	1737	6303	E7W	76
1531	EWR	1836	436	320	150
1535	FAR	1738	6231	CRJ	50
1540	TVC	1748	3845	ERJ	50
1540	IAH	1828	1987	739	167
1550	MSN	1646	4174	ERJ	50
1550	MLI	1647	3659	CR7	70
1550	ATW	1648	4278	ERJ	50
1550	AZO	1752	4137	ERJ	50
1550	IND	1752	3441	E70	70
1550	ICT	1754	3553	E70	70
1550	CLE	1810	3905	E70	70
1551	SPI	1649	5472	CRJ	50
1551	SBN	1740	5573	CRJ	50
1551	BHM	1743	5970	ERJ	50
1551	MEM	1749	6117	ERJ	50
1551	FWA	1752	5331	CRJ	50
1551	TUL	1754	5973	ERJ	50

Hub Time	Dest	Arr Time	Flight	Equip	Seats
1750	SAV	2057	4365	ERJ	50
1752	MCI	1927	4991	CR7	70
1752	MSP	1930	5484	E7W	76
1754	MKE	1847	5455	CRJ	50
1800	SDF	2018	3447	E70	70
1800	BUF	2030	6001	ERJ	50
1800	DCA	2059	624	319	128
1800	EWR	2114	330	739	167
1800	LGA	2114	692	73G	118
1802	HPN	2107	3819	ERJ	50
1802	PVD	2115	4541	ERJ	50
1805	FRA	0935	907	777	266
1815	SCE	2054	6026	ERJ	50
1815	ROA	2058	4108	ERJ	50
1815	IAD	2106	225	738	166
1815	CHS	2127	4096	ERJ	50
1820	CDG	0940	987	763	183
1825	CVG	2041	5691	E7W	76
1840	AVL	2122	5329	CRJ	50
1845	BWI	2140	597	738	166

QSI forecasts

What about market sizes? Will this flight draw passengers?

- Annualized daily market sizes and fares to UA's reachable destinations

Dest	PDEW	Fare	Existing Deps	Existing Seats
LGA	870	$163	42	5,407
EWR	812	$162	20	2,288
BOS	624	$158	23	3,431
PHL	362	$163	15	2,294
ATL	334	$145	28	3,512
HPN	310	$194	6	318
DCA	251	$155	22	2,684
BWI	233	$131	11	1,181
BDL	189	$158	9	717
DTW	132	$181	20	1,845
DFW	124	$178	25	3,579
LAX	114	$221	26	4,371
CLT	99	$208	14	2,103
PIT	80	$133	13	1,096
DEN	78	$174	20	3,244
PVD	63	$142	4	355
BUF	53	$138	10	788
STL	52	$177	16	1,222
AVL	52	$76	2	107
MSP	51	$200	26	3,290

Dest	PDEW	Fare	Existing Deps	Existing Seats
RDU	50	$135	9	1,097
IAD	48	$109	6	774
LAS	48	$228	15	2,578
IAH	47	$219	17	2,410
SFO	47	$249	27	4,253
CMH	46	$152	15	1,229
ALB	43	$157	7	550
IND	41	$179	17	1,133
ROC	40	$158	8	567
PHX	38	$225	13	2,190
MKE	37	$153	15	743
SAN	37	$263	10	1,590
MCI	35	$167	13	1,126
SEA	35	$254	15	2,466
BNA	33	$205	15	958
RIC	31	$147	9	569
CLE	31	$193	16	1,434
SDF	24	$206	10	581
BTV	23	$183	4	257
ORF	21	$189	7	454

QSI forecasts

What are the eastbound results of the QSI model run?

- The first line shows locals – almost half of the QSI gets almost half of the traffic
- Subsequent lines show traffic to beyond destinations
- The load factor from this run is 54% - not as good as we would want

O&D Org	O&D Dst	Service Type	Aircraft Type	Ind Pax	Ind Fare $	O&D QSI Value	Ind QSI Total	QSI Fair Share	Seg Pax	Seg Rev $	O&D Rev $
PBI	ORD	Nonstop	Narrow	176.6	$158	6.744	27.175	25%	43.8	$6,925	$6,925
PBI	ANC	Single cnx	Narrow	10.3	$470	0.210	0.280	75%	7.7	$1,226	$3,631
PBI	LAX	Single cnx	Narrow	87.3	$190	0.296	4.546	7%	5.7	$529	$1,081
PBI	PDX	Single cnx	Narrow	36.3	$223	0.256	1.983	13%	4.7	$501	$1,044
PBI	JAC	Single cnx	Narrow	6.1	$596	0.120	0.187	64%	3.9	$1,160	$2,333
PBI	SFO	Single cnx	Narrow	53.4	$240	0.259	3.765	7%	3.7	$395	$881
PBI	SAN	Single cnx	Narrow	39.5	$262	0.222	2.553	9%	3.4	$395	$901
PBI	DEN	Single cnx	Narrow	56.2	$188	0.251	4.285	6%	3.3	$361	$618
PBI	SEA	Single cnx	Narrow	44.6	$233	0.268	3.752	7%	3.2	$342	$743
PBI	ASE	Single cnx	Narrow	3.0	$359	0.096	0.096	100%	3.0	$563	$1,077
PBI	LAS	Single cnx	Narrow	48.7	$179	0.253	4.104	6%	3.0	$272	$537
PBI	FAI	Single cnx	Narrow	3.2	$441	0.120	0.151	79%	2.5	$383	$1,121
PBI	YVR	Single cnx	Narrow	11.9	$280	0.233	1.188	20%	2.3	$275	$653
PBI	SNA	Single cnx	Narrow	19.4	$249	0.216	1.866	12%	2.2	$249	$560
PBI	BDL	Single cnx	Narrow	159.6	$145	0.163	11.692	1%	2.2	$193	$323
PBI	DTW	Single cnx	Narrow	140.3	$159	0.221	13.976	2%	2.2	$280	$353
PBI	BZN	Single cnx	Narrow	3.1	$236	0.096	0.138	70%	2.2	$252	$511
PBI	PIT	Single cnx	Narrow	75.1	$134	0.176	6.291	3%	2.1	$198	$282
PBI	BOI	Single cnx	Narrow	4.0	$297	0.192	0.369	52%	2.1	$283	$619
PBI	MSP	Single cnx	Narrow	51.3	$192	0.251	6.319	4%	2.0	$296	$391

QSI forecasts

Have we completed our route forecast for PBI-ORD yet?

- The southbound direction forecasted similar results
- The QSI model has forecasted fair shares for hundreds of markets for us
- The QSI model really doesn't have much common sense, however
- The model still forecasts "with all other things being equal"
- For example, itineraries that only connect one-way should be pared
- We still need to factor in real-world issues that affect this market

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QSI adjustments

How do we inject these adjustments into the QSI forecasting process?

- Every factor we've discussed can generally be fine-tuned to some degree
- At what points in the process do we make these adjustments
  - The first opportunity is to adjust the raw data itself
  - Many issues can also be addressed after obtaining the results from the forecast
- QSI models also generally contain features to adjust for certain data points

QSI adjustments

What should we change about the raw input data?

- Market size files are always historical and we're looking forward
  - Tweaking for overall economic conditions is usually the first item to address
  - This adjustment usually affects both traffic and fares
- Industry schedule files can also be modified
  - Remove a carrier that is going out of business
  - Remove a flight that is getting cancelled
- QSI models generally have functionality to support these adjustments

QSI adjustments

What about other inputs into the QSI forecasting tool?

- The QSI values assigned earlier were pretty straightforward
  - Continuous QSI helps with varied aircraft configurations
  - Time of day adjustments can favor an 0800 flight versus an 1100 flight
  - Day of week adjustments can allocate business versus leisure passengers
  - Longer connection times can be penalized
  - Code share flights can have different factors than regular flights
  - Dominance at an airport can gain QSI bonuses for “presence”
- Experimenting with new flight information is also key
  - Adjusting the flight times can optimize connectivity on both ends
  - Tinkering with the aircraft type can affect QSI values, load factors and costs

QSI adjustments

What type of adjustment options do QSI forecasting tools support

- QSI values
- Connection time windows and circuity
- Metro areas
  - Historical data for cities with more than one airport generally separates the figures
  - Combining the airport traffic numbers would more accurately reflect demand in most cases
- Code sharing
  - Would the new flight have code share passengers from partner airlines?
  - If so, factoring in those passengers could provide a significant boost
- And most importantly, traffic stimulation and share gaps

QSI adjustments

What about adjusting the market size information itself

- Analyzing stimulation levels is a topic in and of itself
- The two main reasons to stimulate traffic are proven in historical data
  - Simply adding capacity makes it easier to travel and passengers will follow
  - If a flight will curb leakage to other airports, traffic should also increase
- Local and connecting traffic generally stimulate at different levels
- Entry by an LCC usually stimulates the market differently than legacy additions
  - LCC's generally enter markets with the intent of lowering fares
  - Decreasing fares usually increases traffic
- QSI models generally have functionality to support stimulation effects
  - It is common to perform complicated stimulations with Excel

Questions? Call or email anytime!

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