Introduction to PODS Passenger Choice Model

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Overview of PODS Architecture

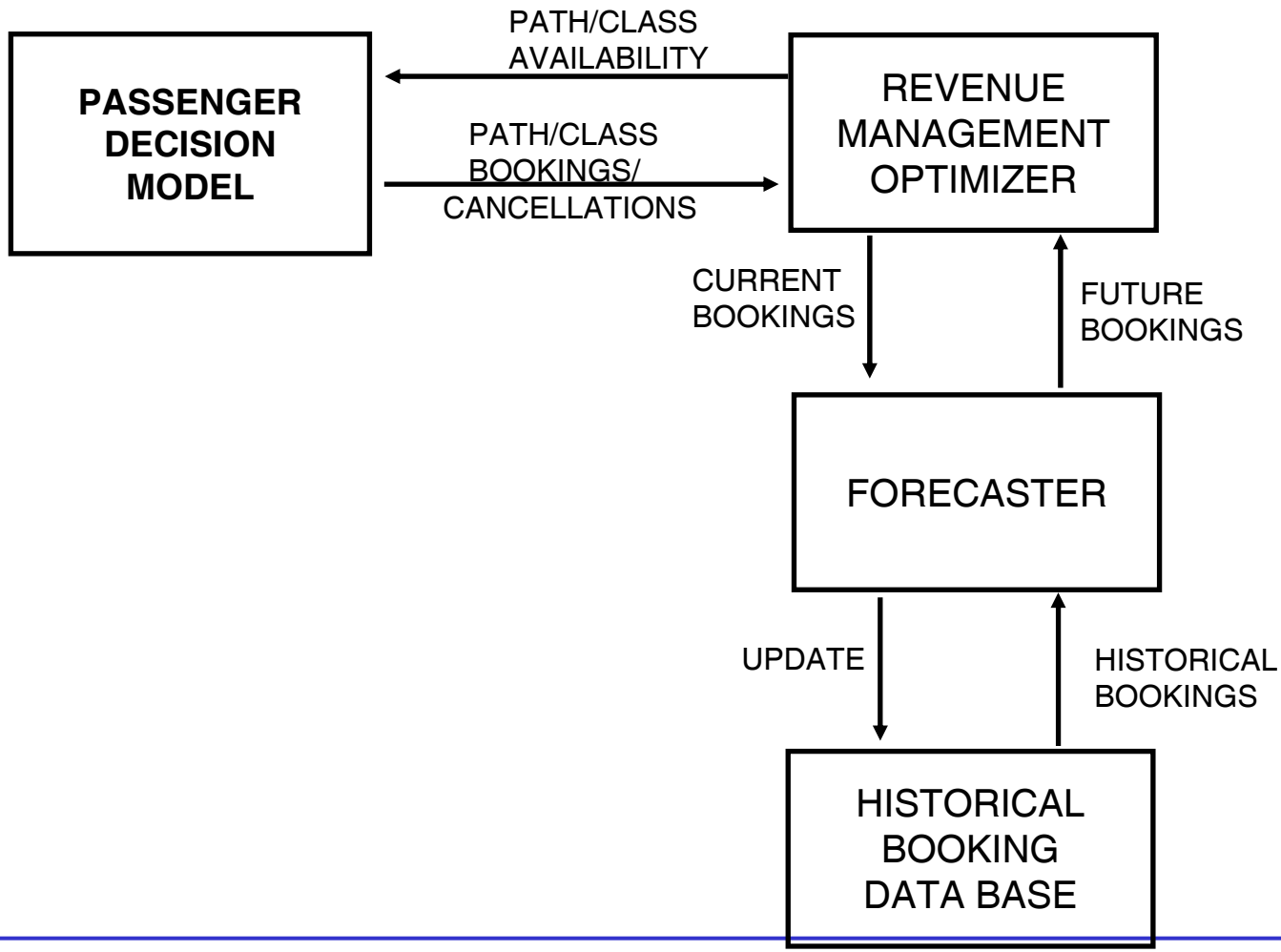
Multiple iterations (samples) of pre-departure booking process and departure day:

- ✈ Stationary process (no trends)
- ✈ Initial input values for demands, then gradual replacement with direct observations
- ✈ “Burn” first n observations in calculating final scores

Pre-departure process broken into time frames:

- ✈ RM system intervention at start of each time frame
- ✈ Bookings arrive randomly during time frame
- ✈ Historical data base updated at end of time frame

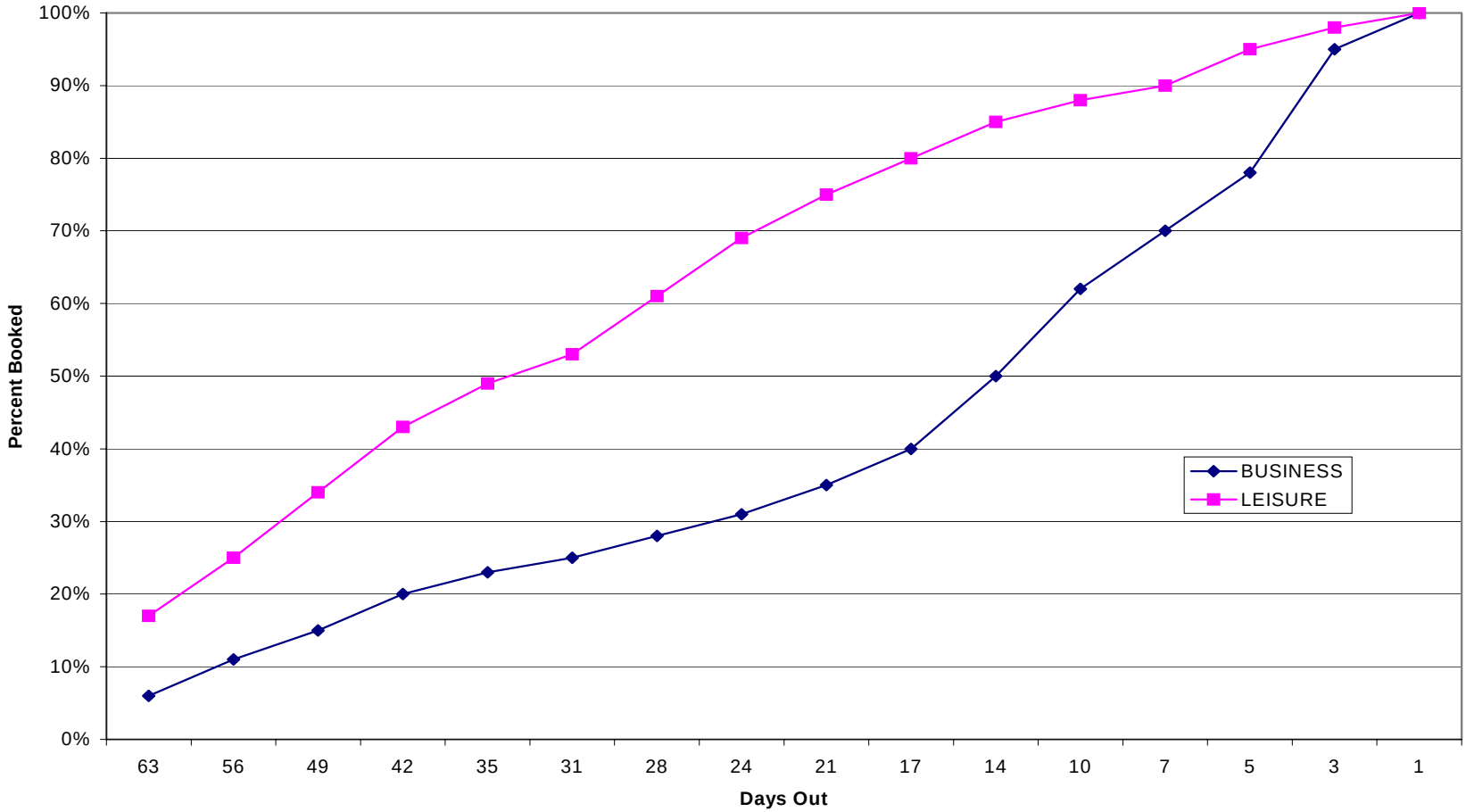
PODS Simulation: Basic Schematic



PODS Demand Inputs

- Total daily demand for an O-D market, by passenger type (business vs. leisure).
- Booking curves by passenger type over 16 booking periods before departure.
- Correlation parameters between passenger types and across booking periods.

Booking Arrival Curves by PAX Type



Business vs. Leisure Passengers

Two passenger types defined by:

- Time of day demand and schedule tolerance
- Maximum out-of-pocket fare willingness to pay
- "Attributed costs" associated with path quality, fare restrictions, trip re-planning

Maximum willingness to pay (WTP) and attributed costs modeled as Gaussian distributions:

- Means and variances (k-factors) specified as inputs
- Each simulated passenger has randomly drawn value from each distribution

Revenue Management Intervention

PODS replicates airline RM system actions over time, taking into account previous interventions:

- ✈ Previously applied booking limits affect actual passenger loads and, in turn, future demand forecasts

"Historical" booking data is used to generate forecasts for "future" departures.

RM system only uses data available from past observations.

Modeling Passenger Path Choice

Define each passenger's "decision window":

- ✈ Earliest departure and latest arrival time
- ✈ Market time-of-day demand profile

Eliminate paths with lowest available fare greater than passenger's maximum willingness to pay

Pick best path from remainder, trading off:

- ✈ Fare levels and restrictions
- ✈ Path quality (number of stops/connects)
- ✈ Other disutility parameters

Choice of Path/Fare Combination

Given passenger type, randomly pick for each passenger generated:

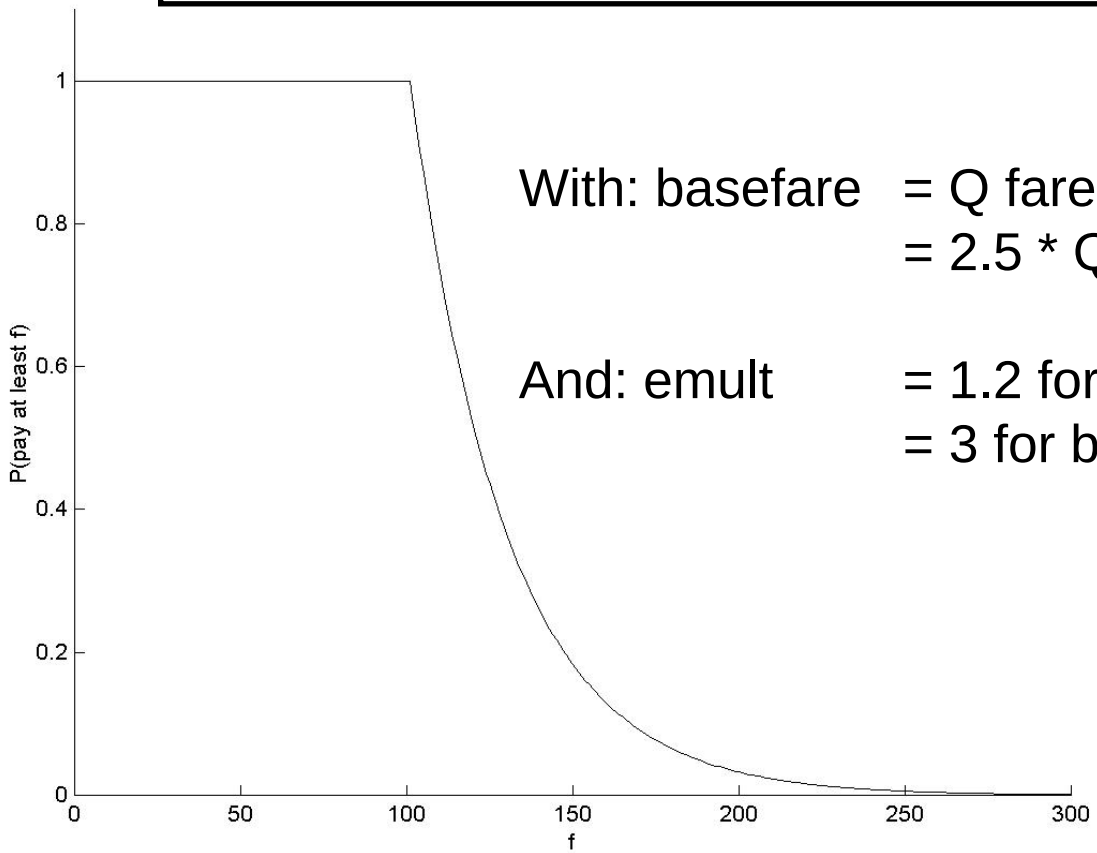
- Maximum “out-of-pocket” willingness to pay
- Disutility costs of fare restrictions
- Additional disutility costs associated with “re-planning” and path quality (stop/connect) costs

Screen out paths with fares greater than this passenger’s WTP.

Assign passenger to feasible (remaining) path/fare with lowest total cost.

Example of WTP Formulation

$$\text{Probability (pay at least } f) = \min[1, e^{\frac{-\log(2) * (f - basefare)}{(emult - 1) * basefare}}]$$



With: basefare = Q fare for leisure passengers
= 2.5 * Q fare for business passengers

And: emult = 1.2 for leisure passengers
= 3 for business passengers

Fare Class Restriction Disutilities

Disutility costs associated with the restrictions of each fare class are added to the fare value to determine the choice sequence of a given passenger among the classes with fare values less than his/her WTP.

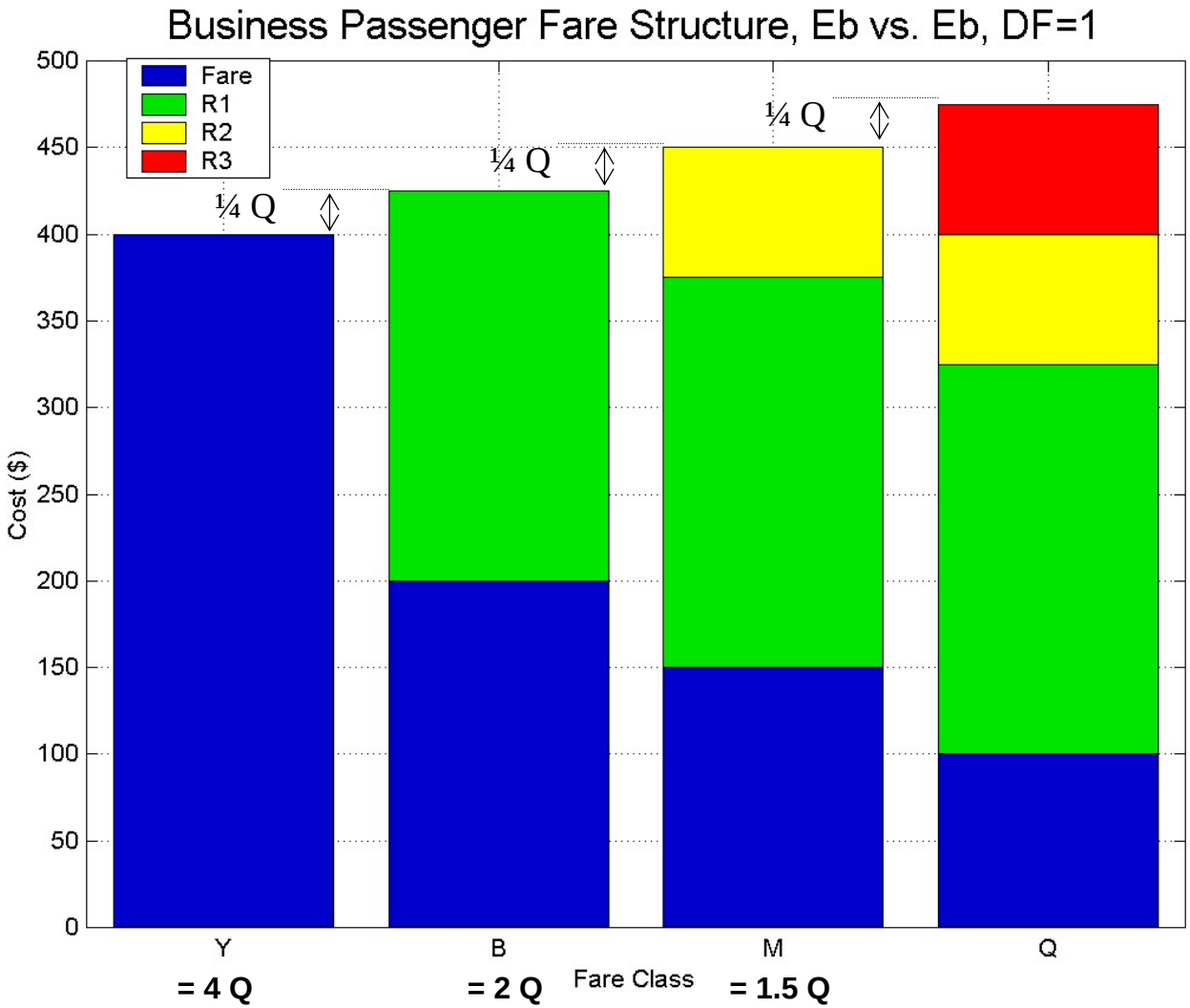
The restrictions are:

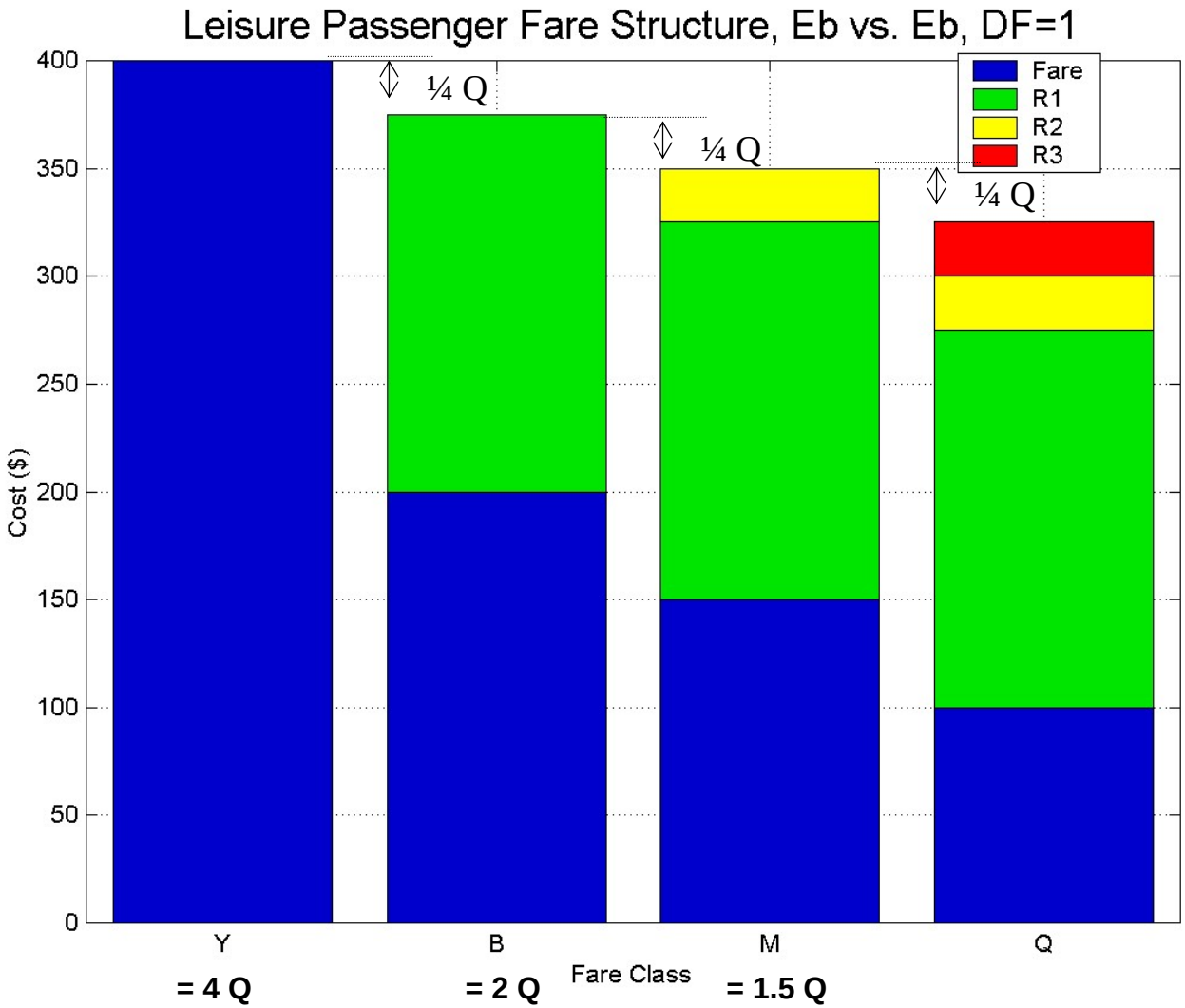
- **R1: Saturday night stay (for M, B and Q classes),**
- **R2: cancellation/change penalty (for B and Q classes),**
- **R3: non-refundability (for Q class).**

Fare Restriction Disutilities

These coefficients have been “tuned” with structured fares so that on average* business and leisure passengers have respectively a Y/M/B/Q and a Q/B/M/Y choice sequence, as shown on the next two slides.

*The following slides represent the mean disutilities for an average passenger. The actual disutility value for an individual passenger is a random number taken from a normal distribution centered on the mean disutility value.


Business Passenger Fare Structure, Eb vs. Eb, DF=1
Fare
R1
R2
R3
¼ Q
¼ Q
¼ Q
Cost ($)
500
450
400
350
300
250
200
150
100
50
0
Y
B
M
Q
Fare Class
= 4 Q
= 2 Q
= 1.5 Q


Leisure Passenger Fare Structure, Eb vs. Eb, DF=1
Fare
R1
R2
R3
¼ Q
¼ Q
¼ Q
Cost ($)
400
350
300
250
200
150
100
50
0
Y
B
M
Q
Fare Class
= 4 Q
= 2 Q
= 1.5 Q

Interpretation of Cost Parameters

Assumed MAX PAY values:

- ✈ Virtually all business passengers will pay Y fare if necessary
- ✈ Most leisure passengers will not buy B, very few will buy M

Assumed relative restriction disutility costs:

- ✈ Average business passenger finds fares with more restrictions less attractive
- ✈ Even with restrictions, most leisure passengers prefer Q fare

EXAMPLE: Fare Structure

Fare Code	Price Level	Advance Purchase	Sat. Night Min. Stay	Non-Refundable	Change Fee
Y	$800	--	--	--	--
M	$400	7 day	Yes	--	--
B	$300	14 day	Yes	Yes	--
Q	$200	21 day	Yes	Yes	Yes

EXAMPLE: Mean Parameter Values

	BUSINESS	LEISURE
MAX PAY (mean)	$1200	$300
Relative Costs: Sat. Night Min. Stay	$450	$350
Non-Refundable	$150	$50
Change Fee	$150	$50

Mean Total Fare Product Disutility ($ Fare + Restriction Costs)

Fare Code	Price Level	Advance Purchase	BUSINESS PASSENGERS	LEISURE PASSENGERS
Y	$800	--	$800	$800
M	$400	7 day	$850	$750
B	$300	14 day	$900	$700
Q	$200	21 day	$950	$650

Total Disutility Costs

- **Passenger path choice criteria: Least total cost**
  - ✈ Total cost = Fare + Restriction disutility + PQI disutility + Replanning disutility + Unfavorite airline disutility
- **Impact of passenger disutilities**
  - ✈ With passenger disutility costs included in PODS simulations, passengers are able to differentiate the "attractiveness" of each path/fare combination, resulting in higher preference for "favorable" paths

Other Disutility Costs

- **PQI disutility cost**
  - Unit PQI disutility cost determined as function of market basefares
  - PQI: 1 for nonstop path, 3 for connecting path
  - PQI disutility cost = Unit PQI disutility cost*PQI
- **Replanning disutility cost**
  - Applies when a given path is outside of passenger's decision window
  - Function of market basefares
- **Unfavorite airline disutility cost (not used in ePODS)**
  - Applies when a given path is not a favorite airline
  - Function of market basefares