Dynamic Pricing & Revenue Management in Service Industries

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RM: Complement of SCM

Revenue Management (RM)	Supply Chain Management (SCM)
RM concerned with *demand-management* decisions.	SCM concerned with *supply* decisions.
“Interface with the market”	Logistics of the firm
Objective: Maximize total profit	Objective: Minimize total cost

Credit: http://en.wikipedia.org/wiki/Demand_chain

Synonymous names:

Yield management. Pricing and revenue optimization. Demand-chain management

RM in Airline	Network RM in Hotel	B2B Pricing Analytics

HYATT

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Hilton

Disneyland Park

Amtrak

AVIS

ebay

Hertz

Google

DELTA

megabus.com stay connected

airbnb

SOUTHWEST

Marriott

FedEx

American Airlines

UBER

starwood Hotels and Resorts

Market Segmentation in Airline Industry

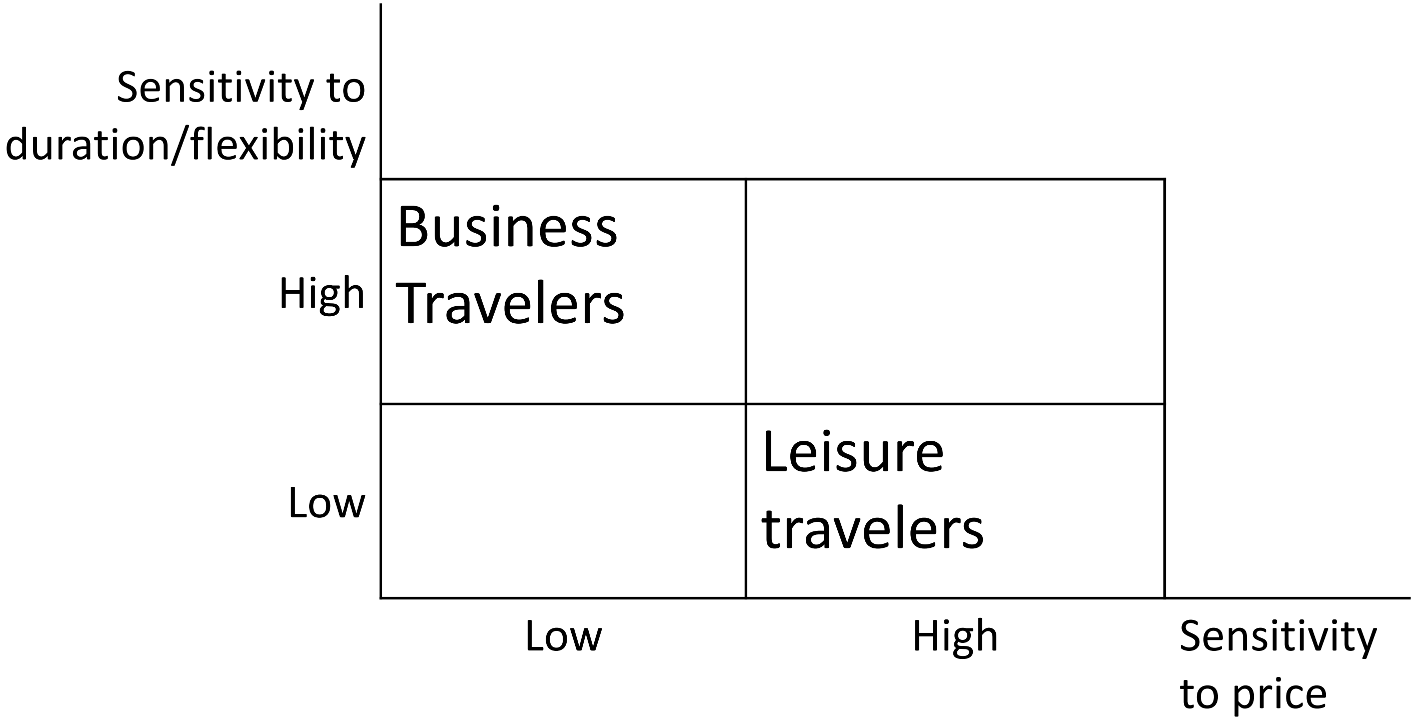
Sensitivity to duration/flexibility		
High	2	1
Low	3	4
	Low	High

Sensitivity to price

Leisure
Business

Source: Simchi-Levi, D., & Kaminsky, P., & Simchi-Levi, E. (2007). Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies. Boston: McGraw-Hill.

Market Segmentation in Airline Industry



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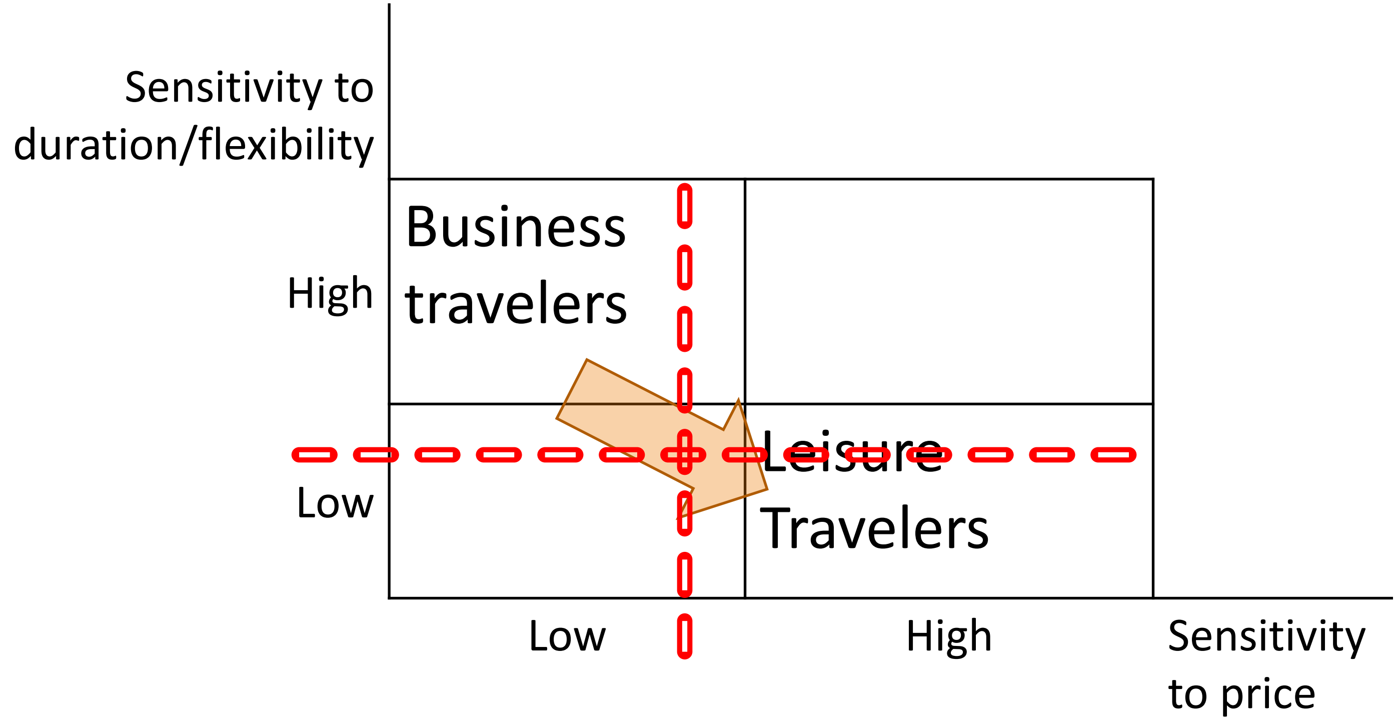
Market Segmentation in Airline Industry



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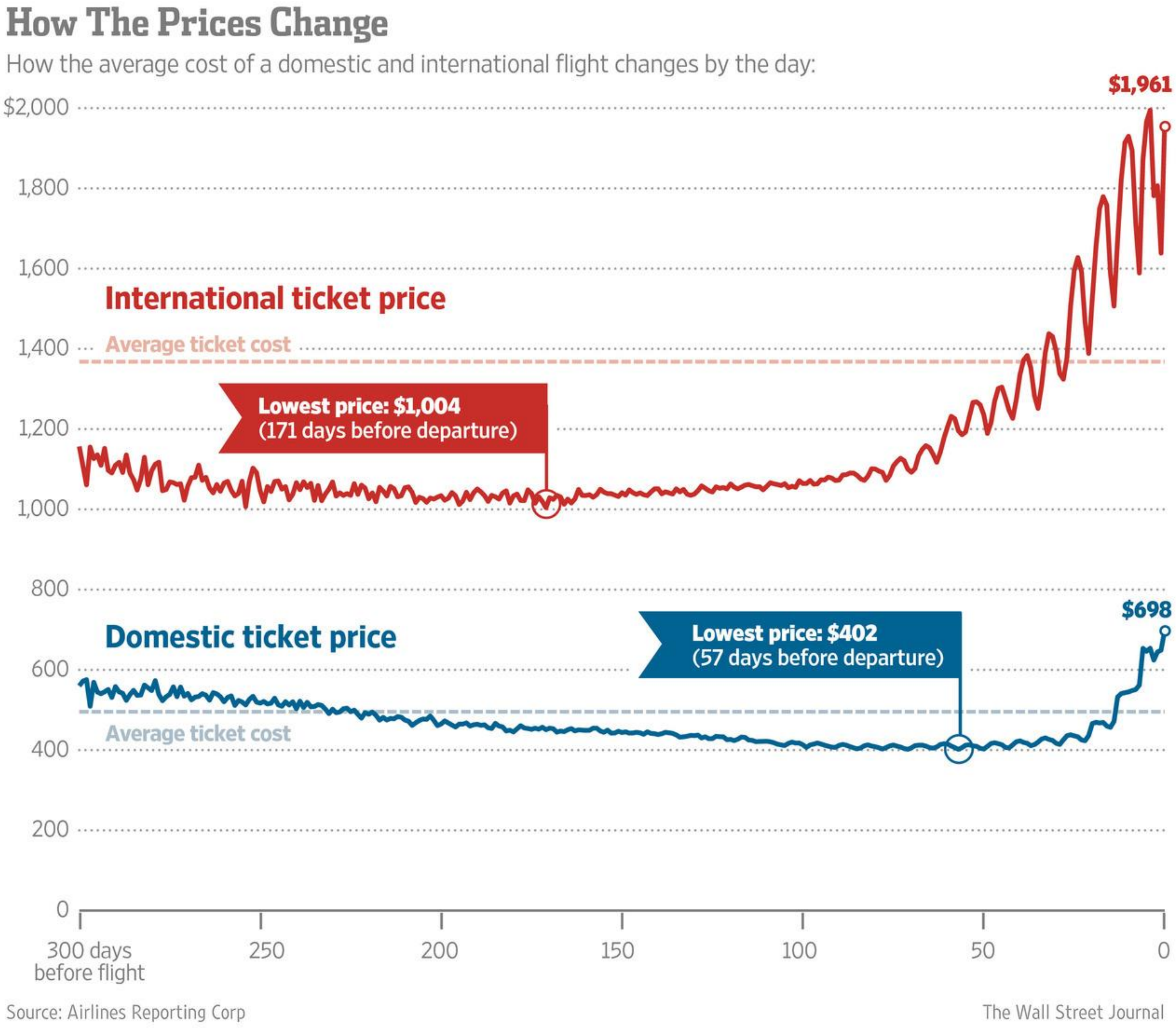
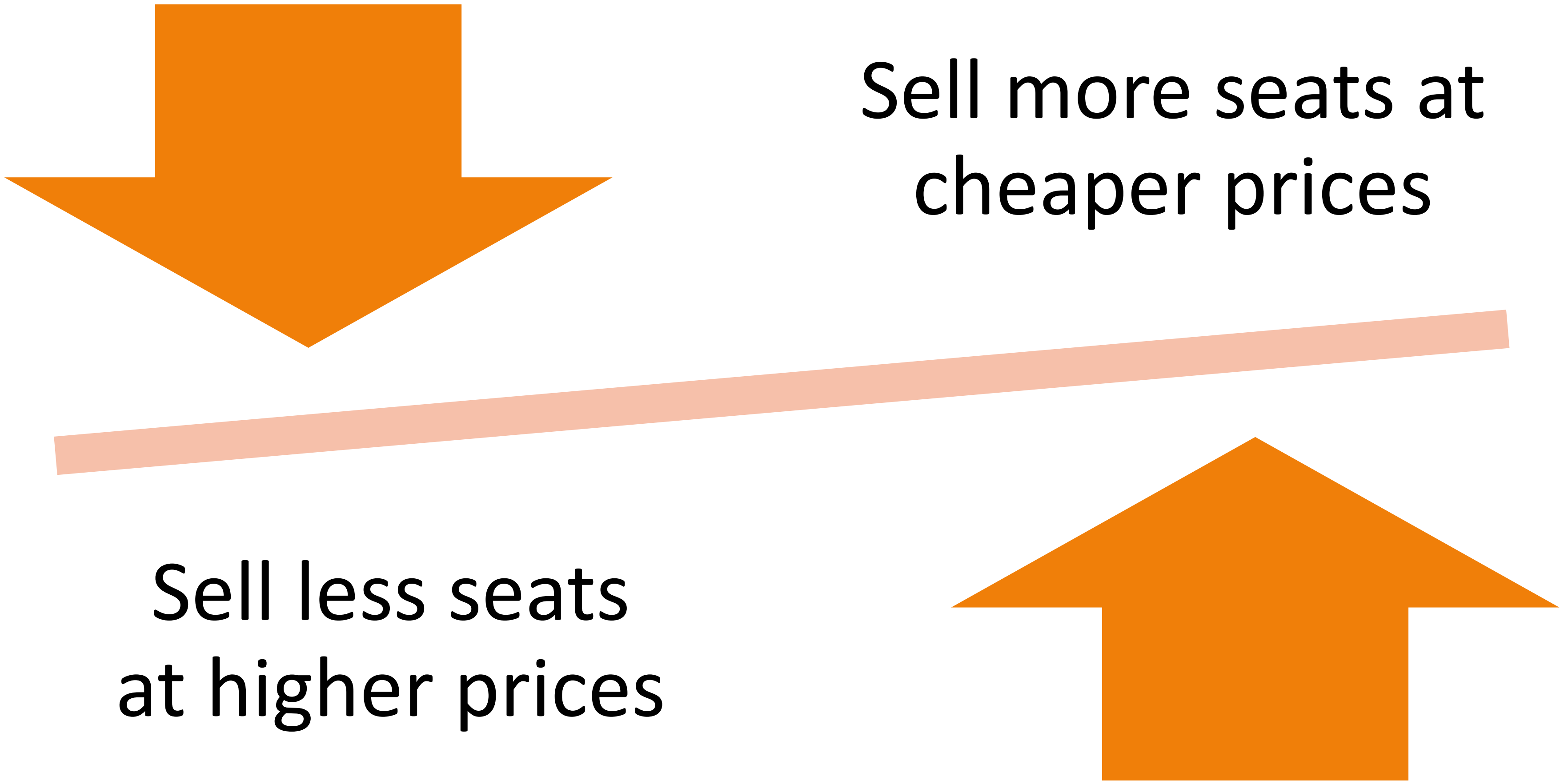
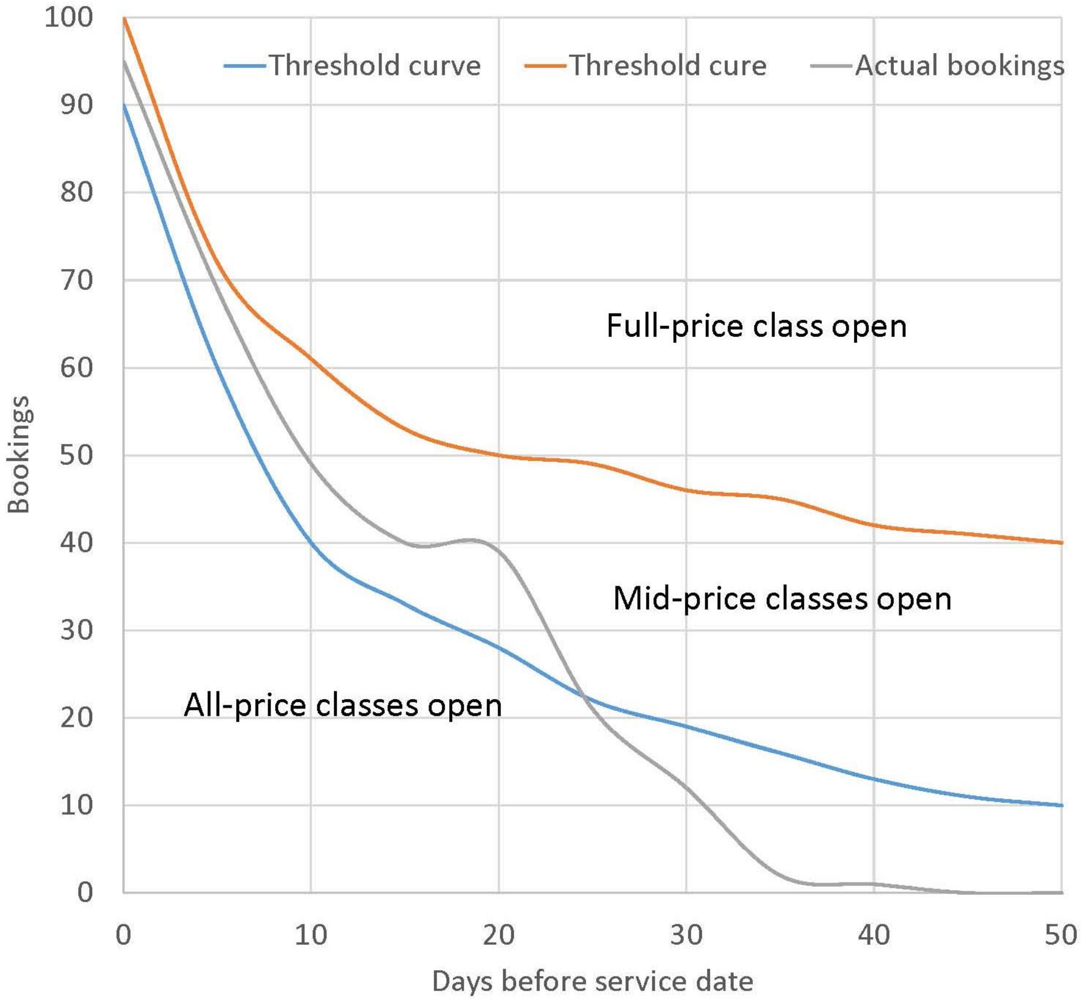

How The Prices Change
How the average cost of a domestic and international flight changes by the day:
$1,961
$2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
International ticket price
Average ticket cost
Lowest price: $1,004
(171 days before departure)
$698
Domestic ticket price
Lowest price: $402
(57 days before departure)
Average ticket cost
300 days before flight
250
200
150
100
50
0
Source: Airlines Reporting Corp
The Wall Street Journal

What is capacity allocation problem?

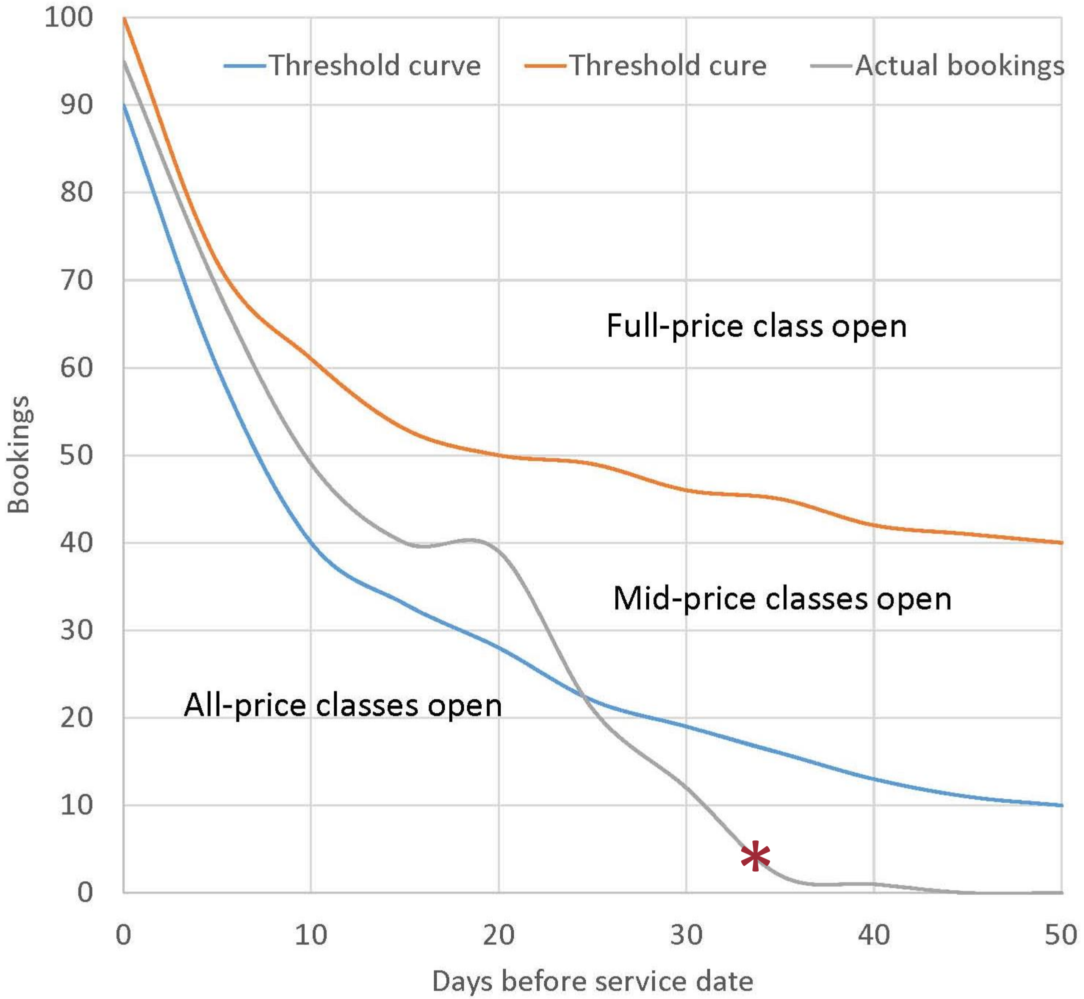


Seat Inventory Control



RM algorithm recommends opening and closing pre-existing classes (Modified from Weatherford (1998))

Seat Inventory Control



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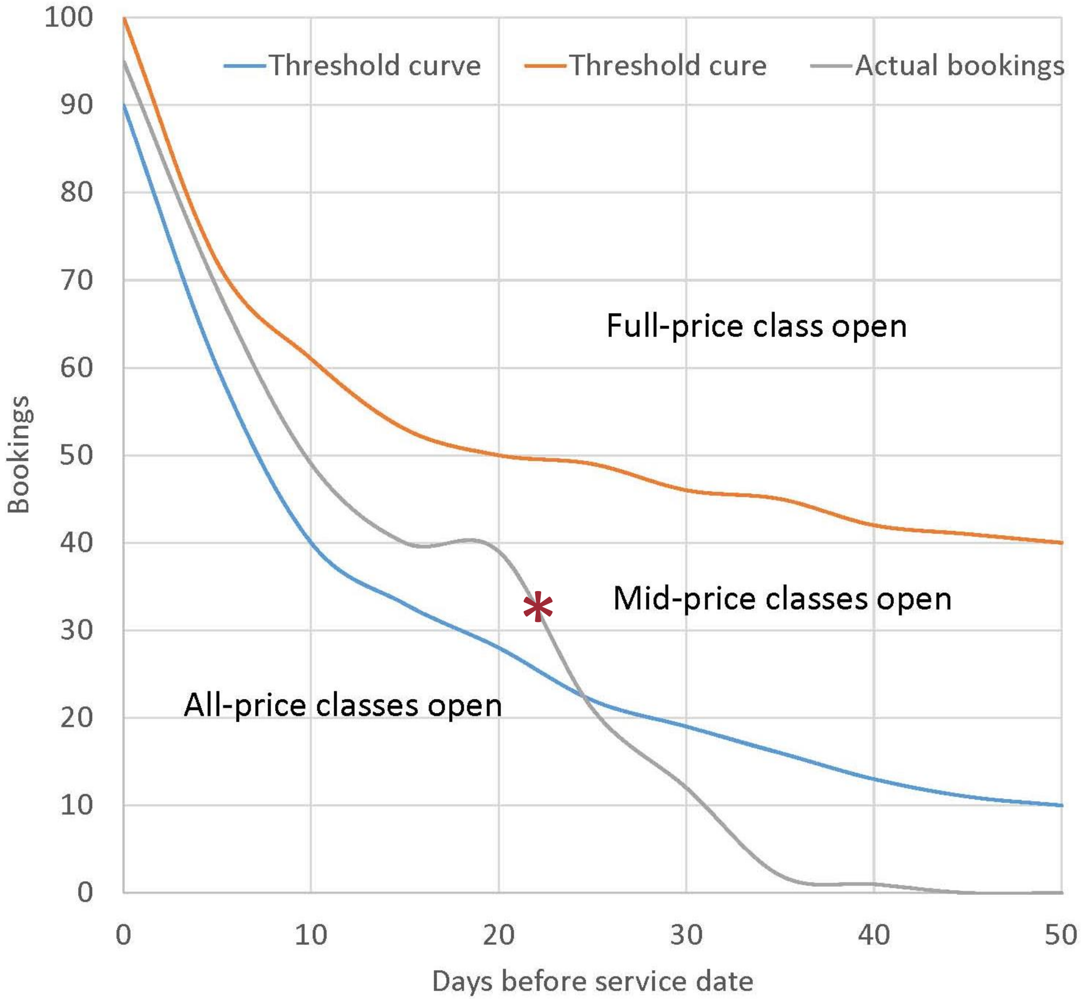
Seat Inventory Control



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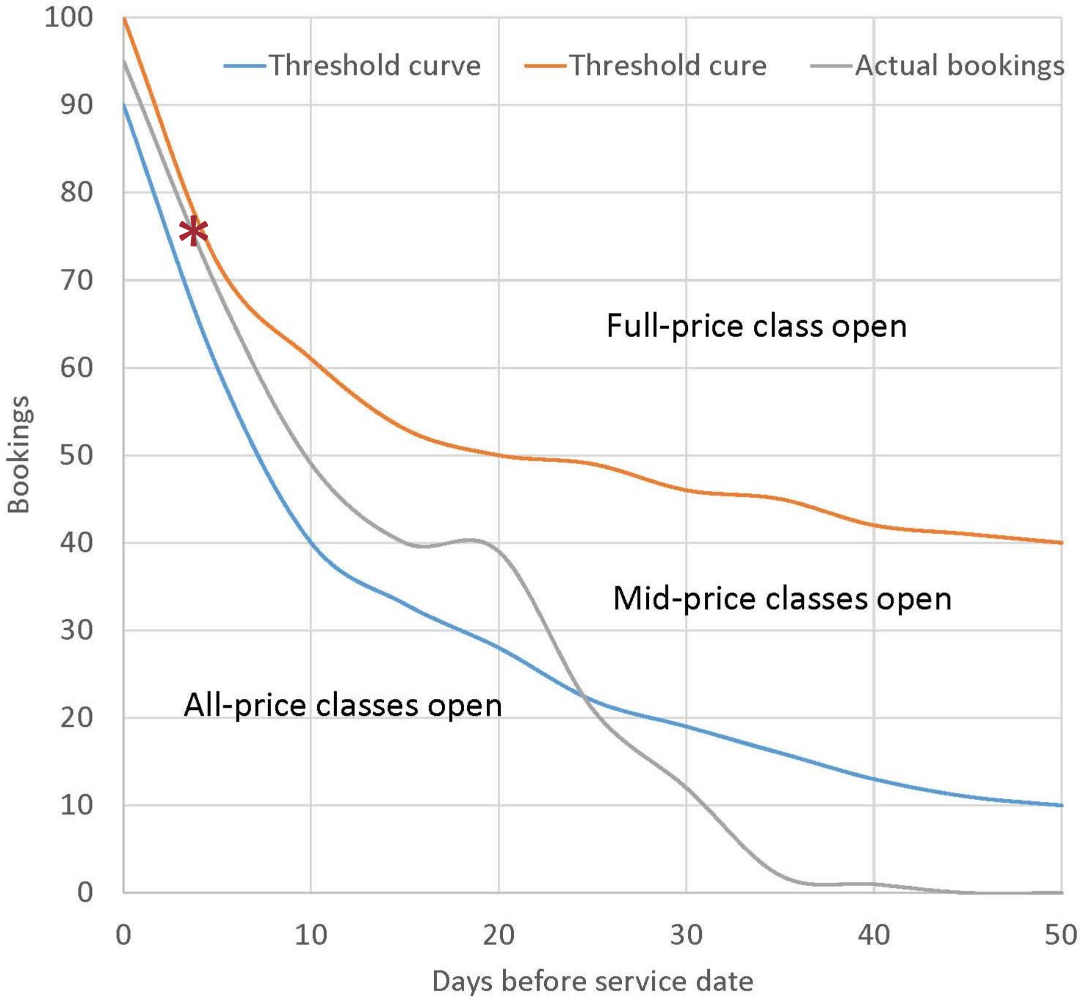
Seat Inventory Control

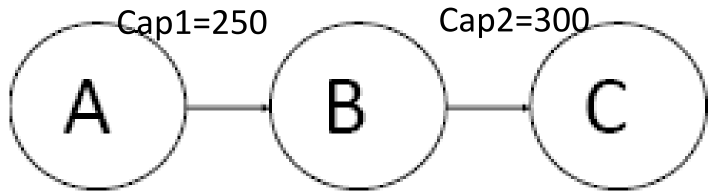


RM algorithm recommends opening and closing pre-existing classes (Modified from Weatherford (1998))

Network management

Industry	Resource unit	Multi-resource product
Passenger airline	Seat on leg	Multi-leg itinerary
Hotel	Room night	Multi-night stay
Rental car	Rental day	Multi-day rental
Passenger train	Seat on a leg	Multi-leg trip
Container shipping	Cargo space on leg	Multi-leg routing

Airline. Container shipping



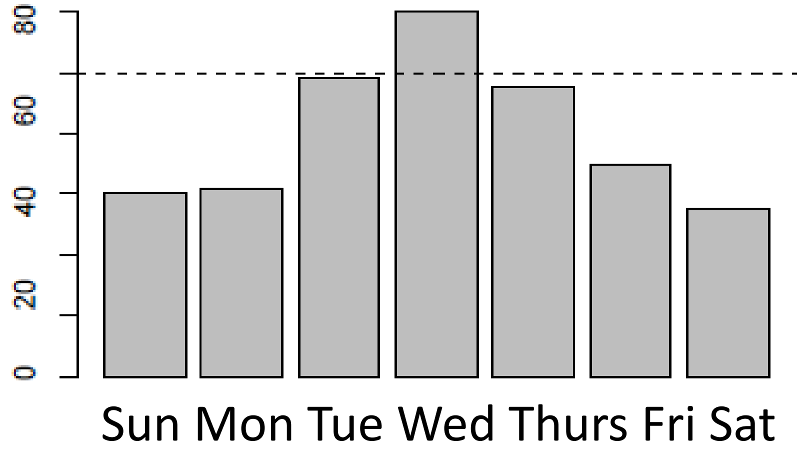
Hotel. Rental car

Description		$a_{i,j}$	Resource (i)						
Arrival	Length of stay	ODF (j)	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Sun	1	1	1	0	0	0	0	0	0
Sun	2	2	1	1	0	0	0	0	0
Sun	3	3	1	1	1	0	0	0	0
Mon	1	4	0	1	0	0	0	0	0
Mon	2	5	0	1	1	0	0	0	0
Mon	3	6	0	1	1	1	0	0	0
Tue	1	7	0	0	1	0	0	0	0
Tue	2	8	0	0	1	1	0	0	0
Tue	3	9	0	0	1	1	1	0	0
Wed	1	10	0	0	0	1	0	0	0
Wed	2	11	0	0	0	1	1	0	0
Wed	3	12	0	0	0	1	1	1	0
Thu	1	13	0	0	0	0	1	0	0
Thu	2	14	0	0	0	0	1	1	0
Thu	3	15	0	0	0	0	1	1	1
Fri	1	16	0	0	0	0	0	1	0
Fri	2	17	0	0	0	0	0	1	1
Sat	1	18	0	0	0	0	0	0	1

Why network RM difficult?

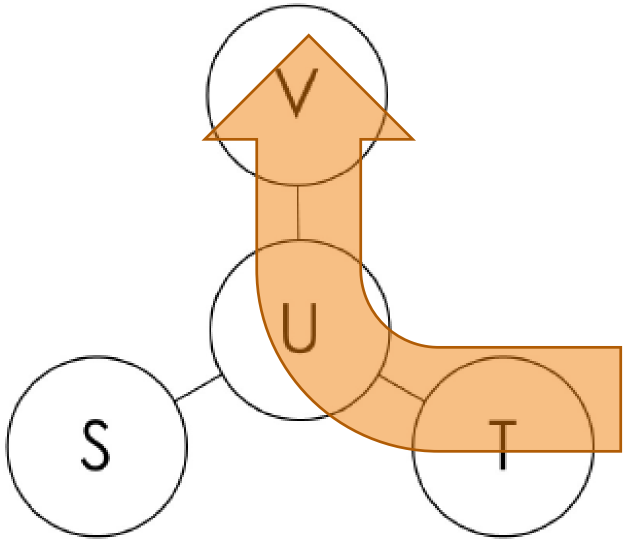
Hotel RM

- Needs to consider both room rate and length of stay



Airline RM

- Needs to consider both OD and fare (ODF)



Class	SU	TU	UV	SV	TV
1	41,000	16,000	12,000	48,000	19,000
2	15,000	14,000	9,700	17,000	16,000
3	9,200	13,000	6,700	8,300	8,400

Bid pricing for hotels

	June						
	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
	30	31	1	2	3	4	5
demand	89	90	113	106	103	66	79
bid price	3206	3502	5824	4274	3518	2065	2369
	6	7	8	9	10	11	12
demand	87	104	136	116	88	48	48
bid price	3361	4634	6542	5410	3637	1604	1232
	13	14	15	16	17	18	19
demand	64	88	109	100	90	74	64
bid price	2067	2750	4658	3803	3514	2100	2070
	20	21	22	23	24	25	26
demand	88	100	157	137	120	93	88
bid price	3388	4944	7596	6549	4643	3824	3233
	27	28	29	30	1	2	3
demand	85	91	110	99	80	58	72
bid price	3200	3555	5916	3843	2996	2050	2382

Bid price calculation

Deterministic linear programming

For each resource i

bid price = shadow price

Maximize $\sum_{j=1}^{n} p_j x_j$

Subject to:

$\sum_{j=1}^{n} a_{ij} x_j \leq b_i$ for each $i = 1, 2, \ldots, m$

$0 \leq x_j \leq d_j$ for each $j = 1, 2, \ldots, n$

Bid price calculation

- Deterministic linear programming

$$\max \sum_{j=1}^{n} p_j x_j$$

$$\sum_{j=1}^{n} a_{ij} x_j \le b_i \qquad \text{for all } i = 1, 2, \ldots, m$$

$$0 \le x_j \le d_j \qquad \text{for all } j = 1, 2, \ldots, n$$

- Randomized linear programming

$$(D_1^{(1)}, D_2^{(1)}, \ldots, D_n^{(1)})$$
$$(D_1^{(2)}, D_2^{(2)}, \ldots, D_n^{(2)})$$
$$\cdots$$
$$(D_1^{(\ell)}, D_2^{(\ell)}, \ldots, D_n^{(\ell)}),$$

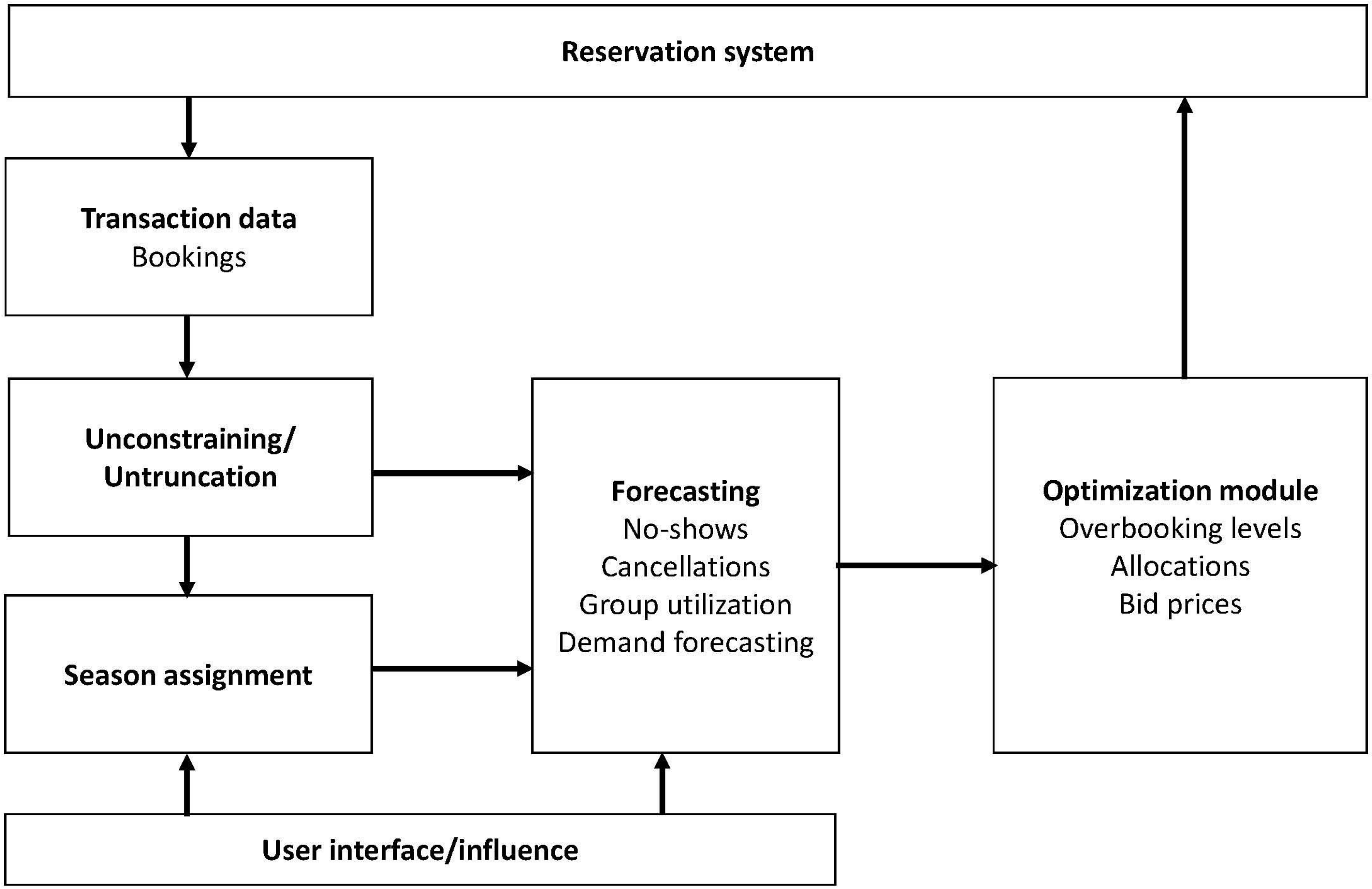
$$\frac{1}{\ell} \sum_{k=1}^{\ell} \nu_i(\mathbf{b}, (D_1^{(k)}, D_2^{(k)}, \ldots, D_n^{(k)})).$$

- Probabilistic nonlinear programming

$$\max \quad \sum_{j=1}^{n} p_j E[\min(X_j, y_j)]$$

$$\sum_{j=1}^{n} a_{ij} y_j \le b_i \qquad \text{for all } i = 1, 2, \ldots, m$$

$$y_j \ge 0 \qquad \text{for all } j = 1, 2, \ldots, n$$

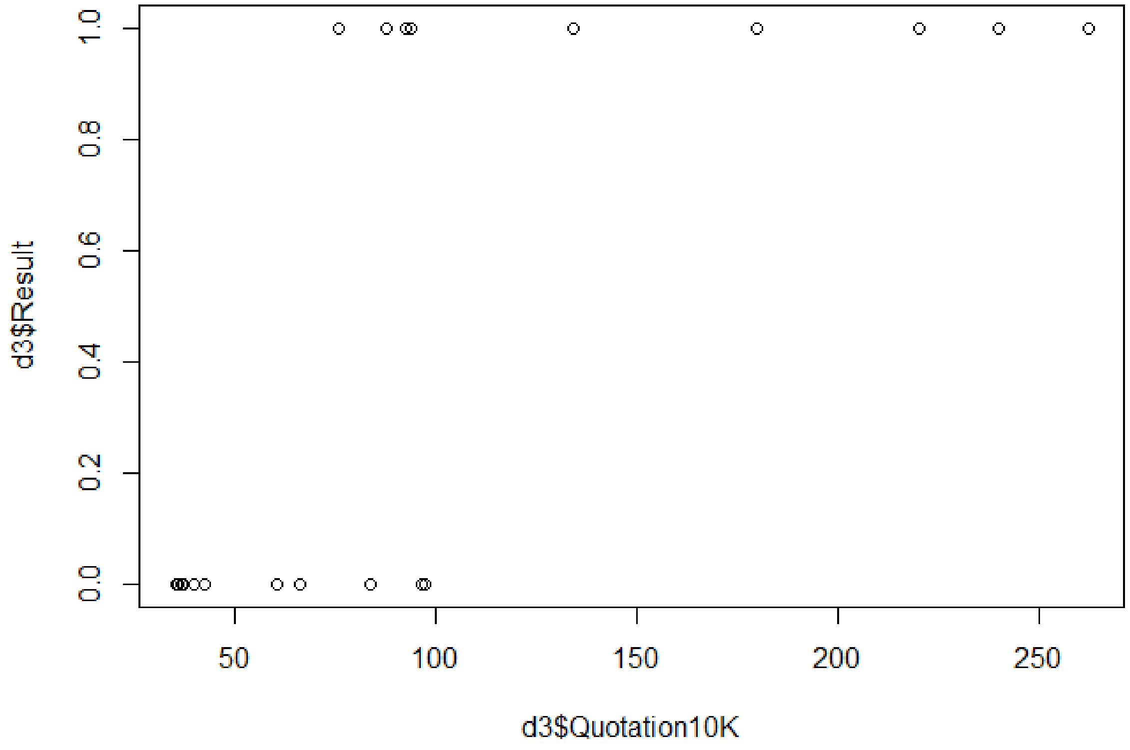

Reservation system
Transaction data
Bookings
Unconstraining/
Untruncation
Season assignment
Forecasting
No-shows
Cancellations
Group utilization
Demand forecasting
Optimization module
Overbooking levels
Allocations
Bid prices
User interface/influence

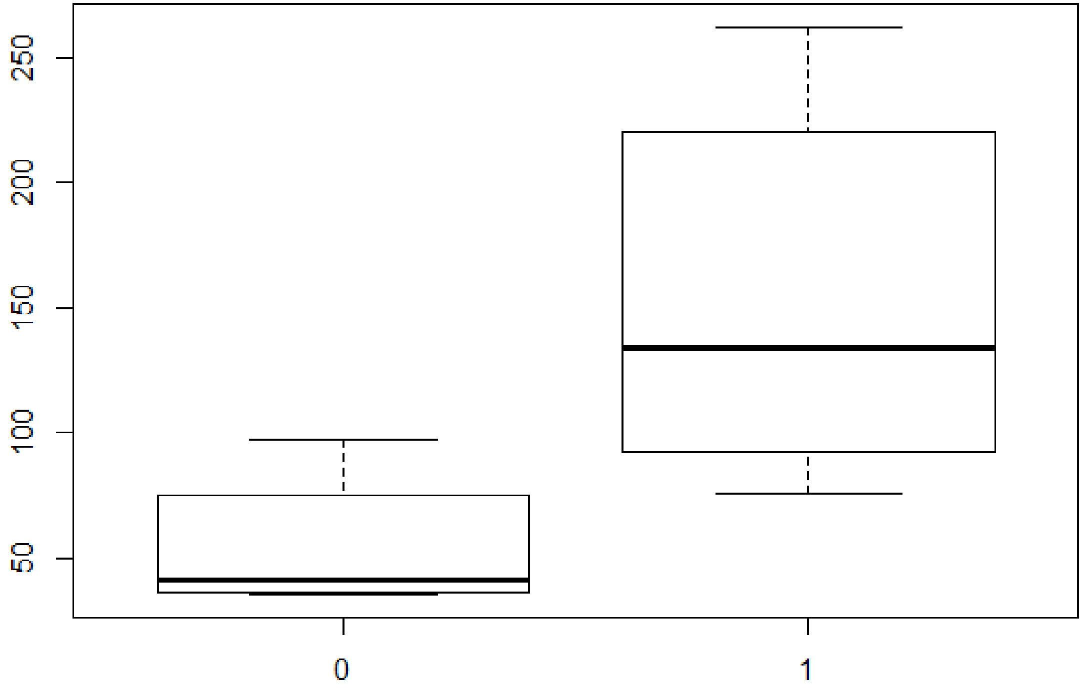
B2B pricing analytics

B2B	**B2C**

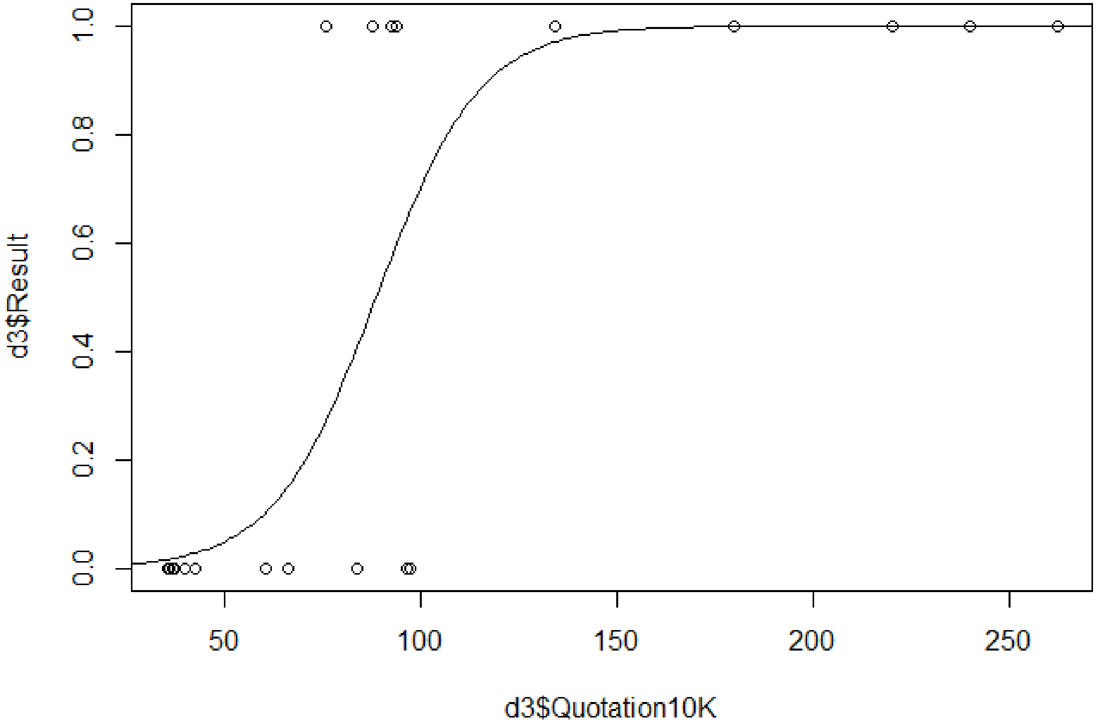
Historical record: Palletizer bidding result

0 = Win 1= Lose





Logistic regression (binary classification)



Let $p = P(Y = 1)$ prob of losing.

$$\text{logit}(p) = \log\left(\frac{p}{1-p}\right) = \theta_0 + \theta_1 x$$

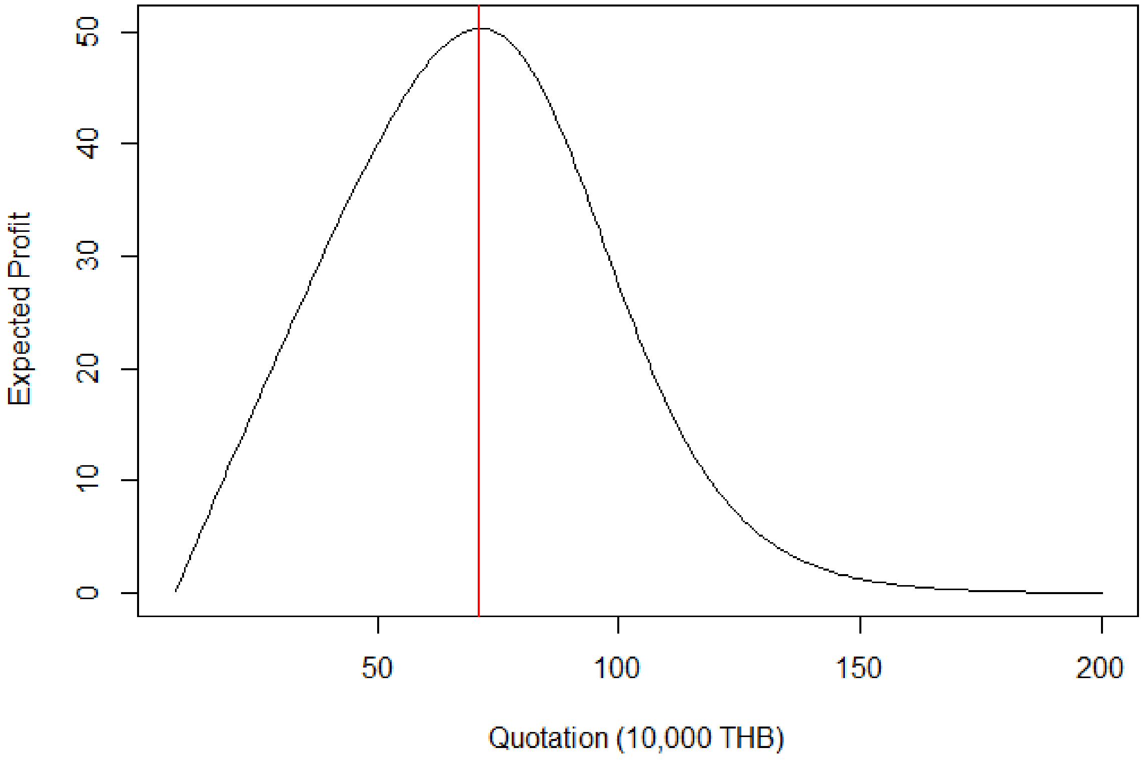
$$p = \frac{1}{1 + \exp(-(\theta_0 + \theta_1 x))}$$

where x is the quotation (in 10K).

```
> exp(mylogit3$coefficient[2])
Quotation10K
    1.079593
```

```
> mylogit3 <- glm(Result~Quotation10K, data=d3, family = "binomial")
Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -6.79908    3.51682  -1.933   0.0532 .
Quotation10K  0.07658    0.04090   1.873   0.0611 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Optimal bid price



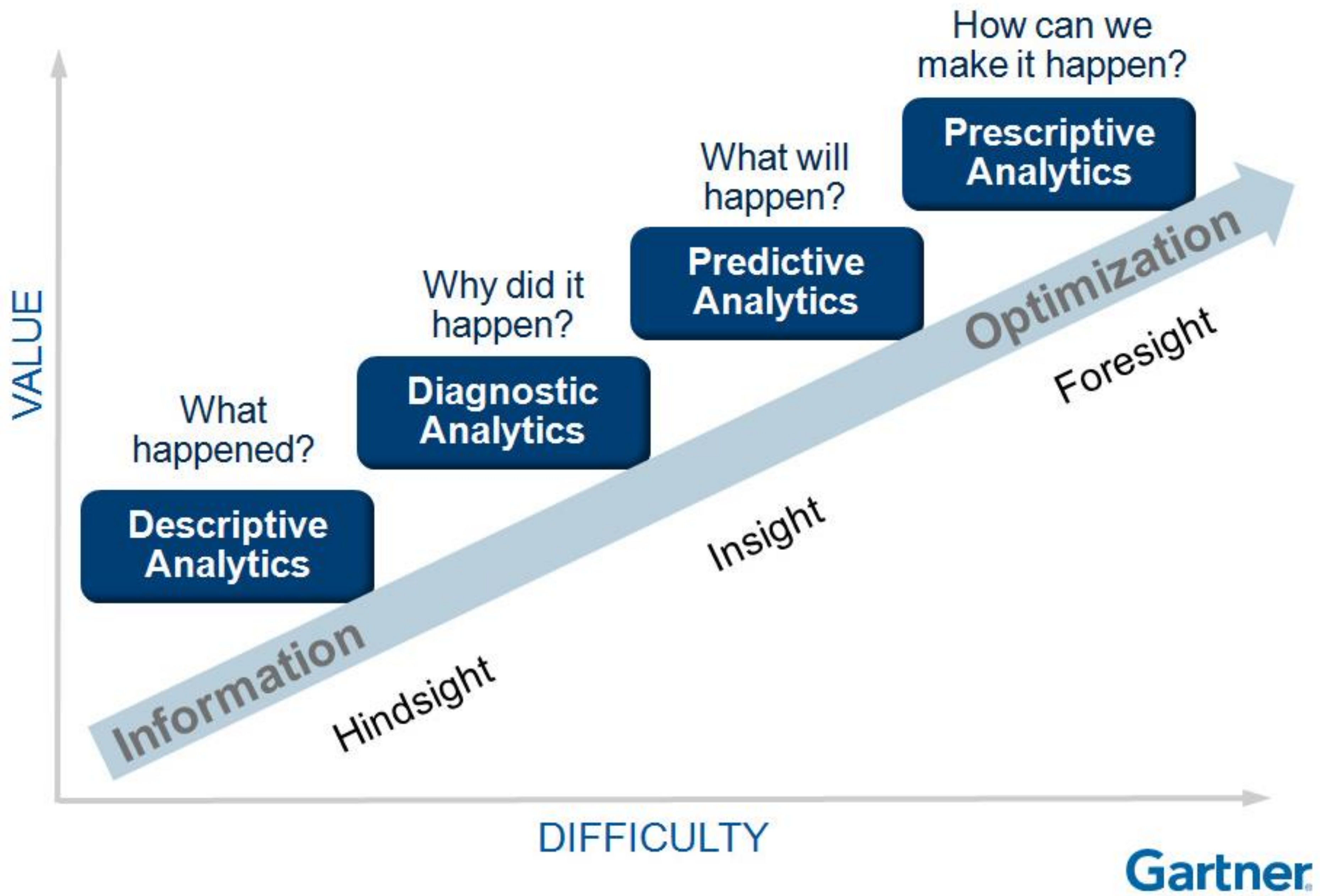
Input

- Cost = 78,291 THB (installation & maintenance)
- Logistic regression

Output

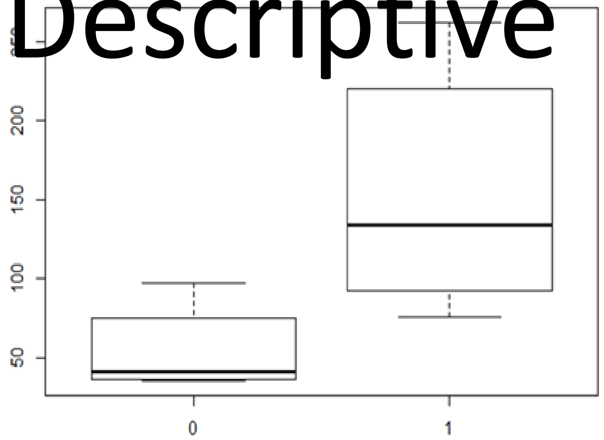
- Optimal bid price = 710,000 THB.
- Probability of winning = 1-0.2040 =0.7960.
- Optimal expected profit = 502,855 THB.

```
profit <- function(x){
  cost <- 7.8291 #78,291 THB
  probL <- predict(mylogit3, data.frame(Quotation10K=x), type="response")
  myprofit <- (1-probL)*(x-cost)
  return(myprofit)
}
```

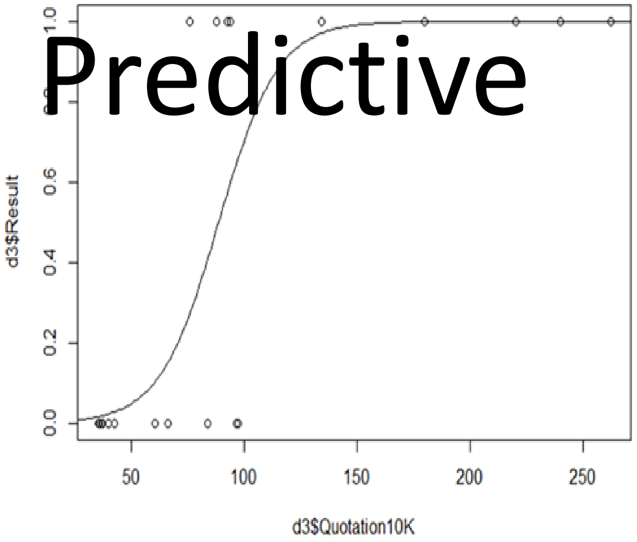

How can we make it happen?
Prescriptive Analytics
What will happen?
Predictive Analytics
Why did it happen?
Diagnostic Analytics
What happened?
Descriptive Analytics
VALUE
Information
Optimization
Hindsight
Insight
Foresight
DIFFICULTY
Gartner

Pricing Analytics

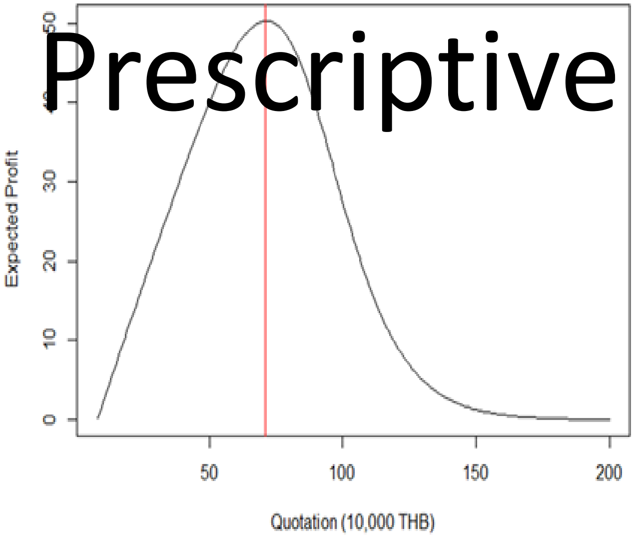
Descriptive



Predictive



Prescriptive



References

- Amaruchkul, K. (2018). *Reveneue Optimization Models*. Bangkok: National Institute of Development Adminstration Press.
- Ingold, A., McMahon-Beattie, U., & Yeoman, I. (2000). *Yield Management: Strategies for the Service Industries.* London: Cengage Learning.
- International Air Transport Association. (2012). *Airline Revenue Management.* Montreal, International Aviation
- Training Program.
- Phillips, R. (2005). *Pricing and Revenue Optimization.* Stanford, CA: Stanford University Press.
- Talluri, K., & van Ryzin, G. J. (2004). *The Theory and Practice of Revenue Management.* Boston, MA: Kluwer Academic Publishers.
- Yeoman, I., & McMahon-Beattie, U. (2011). *Revenue Management: A Practical Pricing Perspective.* New York: Palgrave Macmillan.
- Yeoman, I., & McMahon-Beattie, U. (2004). *Revenue Management and Pricing: Case Studies and Applications.* London: Thomson Learning.

SE-ED
inspiration starts here

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สาขาที่มีจำหน่าย

Revenue Optimization Models

Addressing an emerging course in Revenue Management, this textbook covers the basic quantitative models in revenue management (RM) and price optimization.

ผู้เขียน **Kannapha Amaruchkul**

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Revenue Optimization Models

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