

MSBA 7004

Operations Analytics

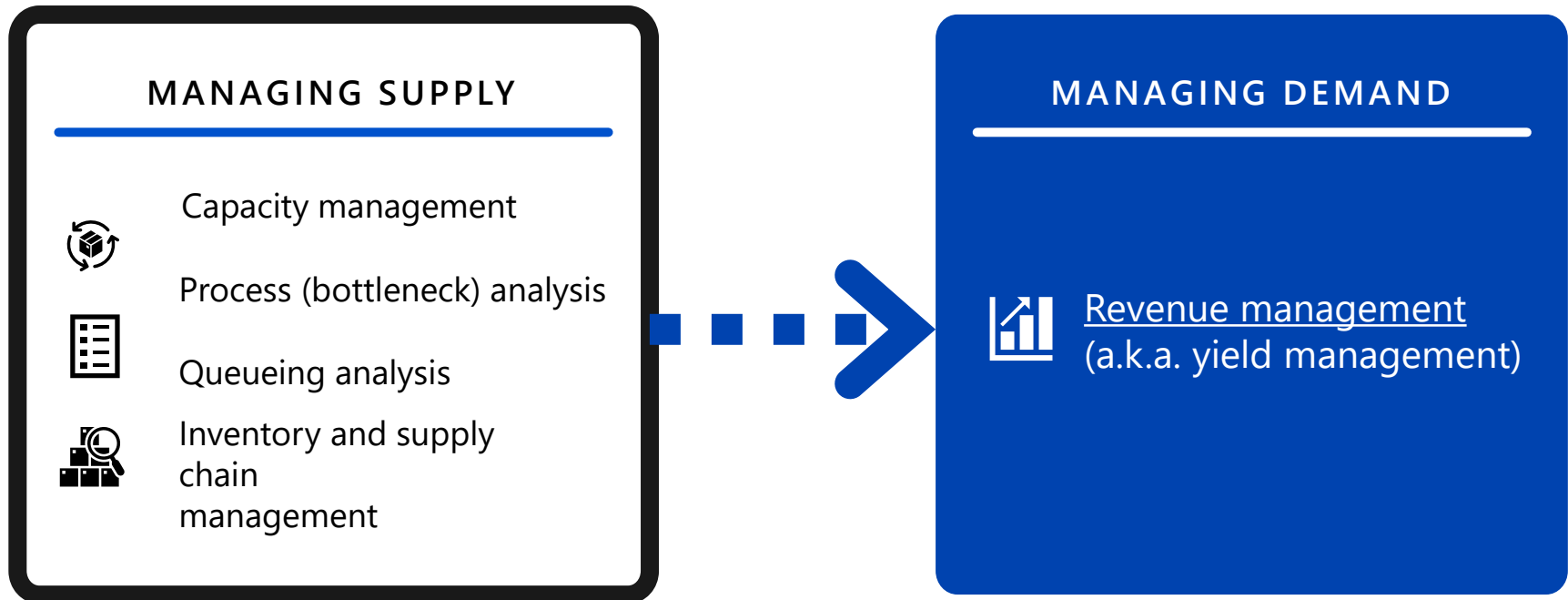
Class 10-1: Revenue Management
2023

Learning Objectives

- Explain the concept of revenue management.
- Understand customer segmentation and price discrimination.
- Apply tools for capacity reservation and overbooking management.

Operations Management Options

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Matching Supply to Demand

When Supply Is Fixed

Examples of fixed supply:



Travel industries (fixed number of seats, rooms, cars, etc.).



Advertising time (limited number of time slots).



Telecommunications bandwidth.



Size of the TPG program.



Doctor's appointments.

Revenue management is a solution:

- If adjusting supply is impossible – adjust the demand!
- Segment customers into high willingness to pay and low willingness to pay.
- Limit the number of tickets sold at a low price, that is, control the average price by changing the mix of customers.

Examples



Hotel Room Pricing



Airlines and Seat Pricing



Disneyland's Tiered Pricing



Uber Surge Pricing



eCommerce and Flash Sales



Cruise Line Cabin Upgrades



Streaming Services and Content Licensing



Online Advertising Auctions



Ride-Sharing Subscription Plans

Revenue Management

*"The process of allocating the right **type** of capacity, to the right kind of customer, at the right price and time, to maximize revenue or yield..."*

*The Art of Managing Yield, **American Airlines** Annual Report, 1987*

American Airlines® VS *PEOPLE*Express



HOW SHOULD AA COMPETE?



Give up the low-end market?



Use price discrimination?



Increase routes or schedules?



Spin off a new budget airline?



Acquire People Express?



"Play dirty"?

THE DECISION



Ultimate Super Saver
January 1985



70% of tickets with higher prices
30% of tickets with lower prices

Newsvendor Model?

RESULT – DOWNFALL OF PE

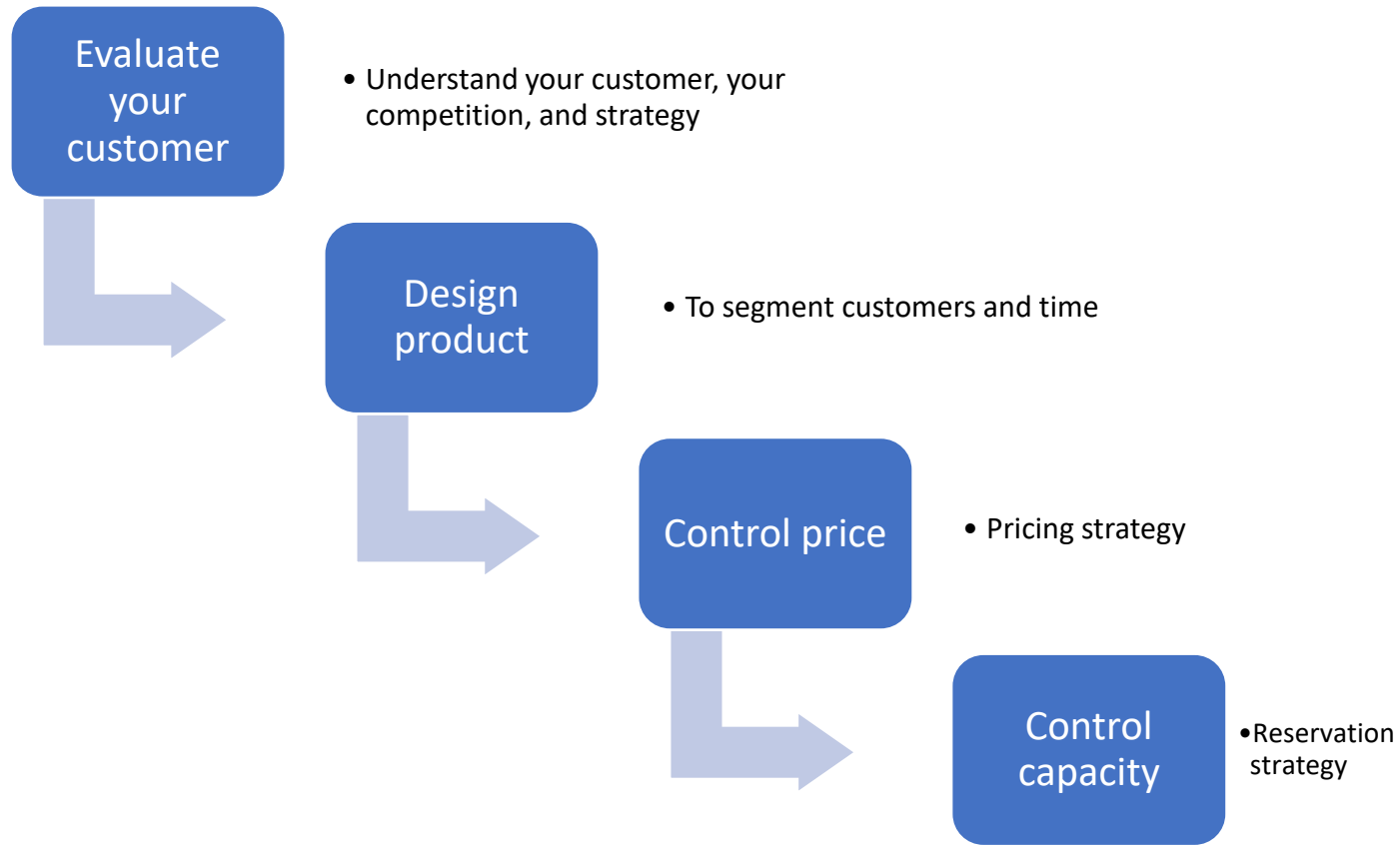


From US\$1 billion profit in 1985
to near-bankrupt in 1986

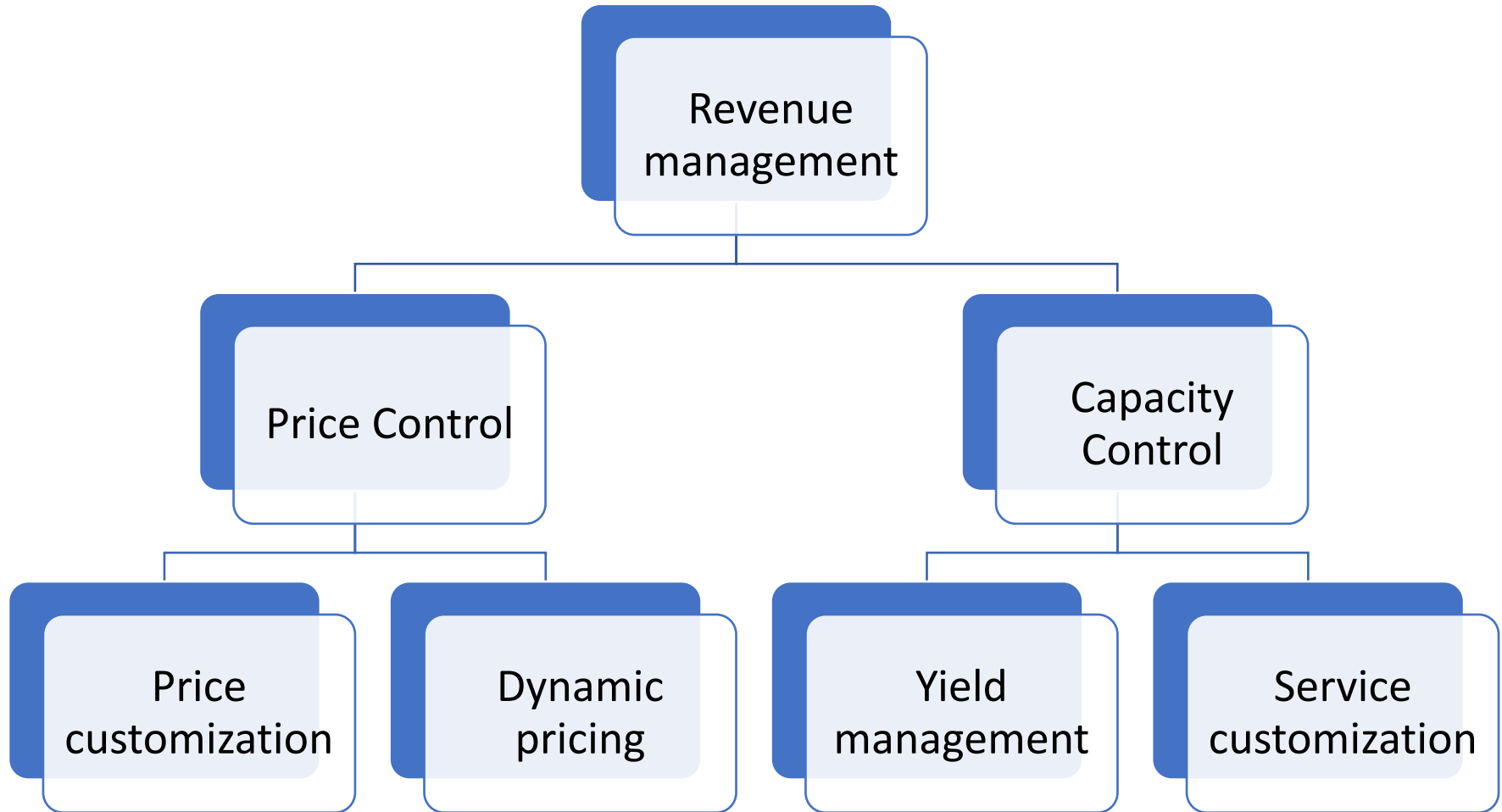


Acquired by Continental in 1987

Revenue Management



Revenue Management



Revenue Management

- Price Control
 - Price customization
 - Dynamic pricing
- Capacity Control
 - Yield management
 - Service customization



Pricing

PRICING A PRODUCT/SERVICE



Intrinsic value



Classical economics:
supply and demand

TRADITIONAL APPROACHES



Cost-plus

Based on

Costs



Market based

Competition



Value based

Customers



China sales of electric vehicles by company

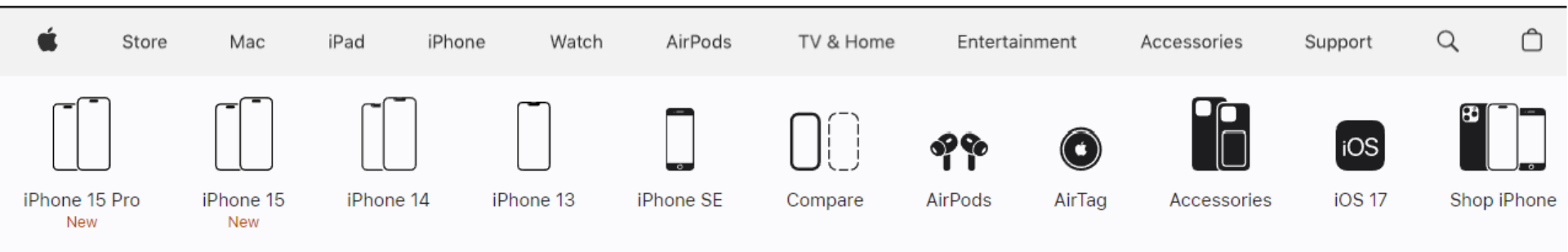
🚗 2022 🚗 2021



Sources: Company websites, Technode, Inside EVs, Electrek, Investor Insights, CNEV Post, CGTN, Moomoo, Auto China.
Some figures are company estimates.

Pricing: iPhone

- 2008: iPhone 3G only
- 2023: iPhone 15 Pro and many more..





Pricing: iPhone

IPHONES ON SALE IN 2008



iPhone 3G
HK\$5,400 / HK\$6,200

IPHONES ON SALE IN 2023



iPhone 15 series
HK\$6,899 – HK\$13,599



iPhone 14 (Plus)
From HK\$5,999



iPhone 13
From HK\$5,099



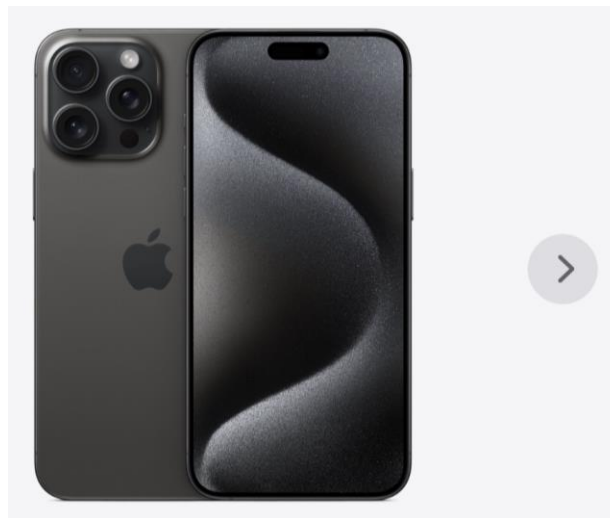
iPhone SE
From HK\$3,699

Pricing: An Important Tool



ONE PRICE DOES NOT FIT ALL

How much will you pay for an iPhone 15 Pro Max 256GB?



Model. Which is best for you?

iPhone 15 Pro

6.1-inch display¹

iPhone 15 Pro Max

6.7-inch display¹

Need help choosing a model?

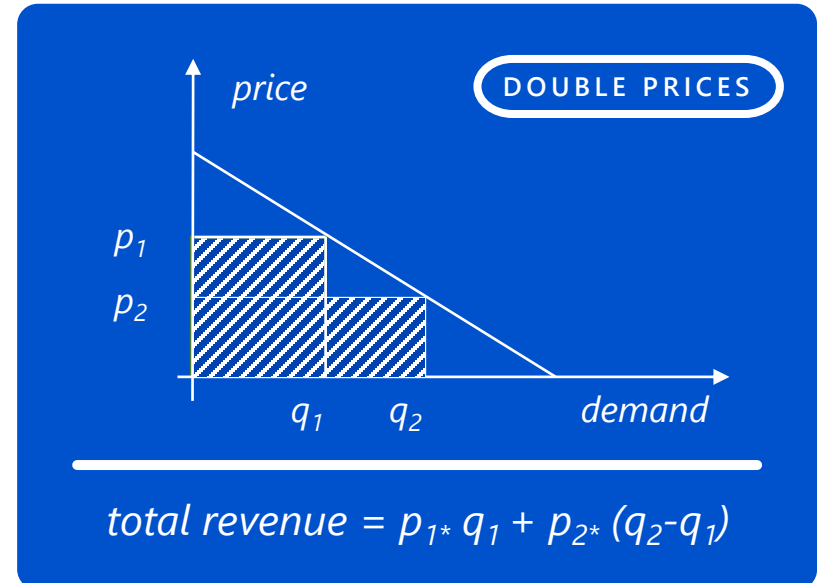
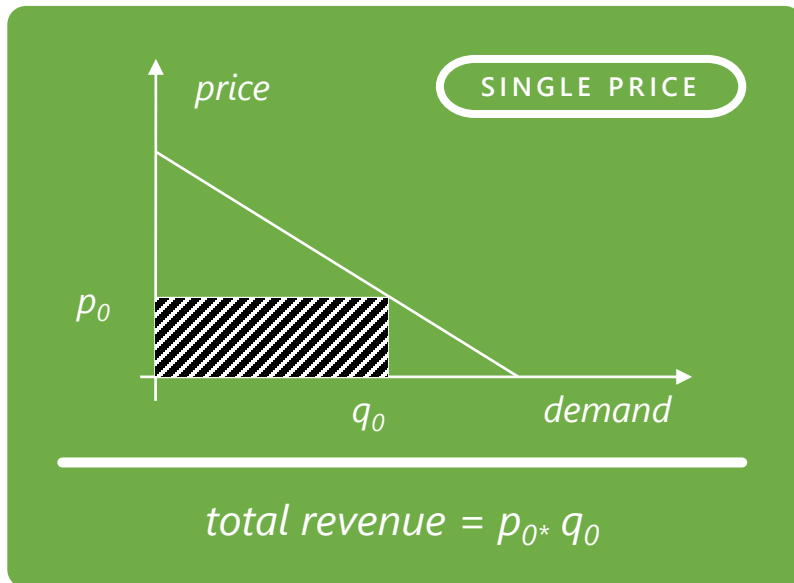
Explore the differences in screen size and battery life.



Pricing: An Important Tool

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ONE PRICE DOES NOT FIT ALL

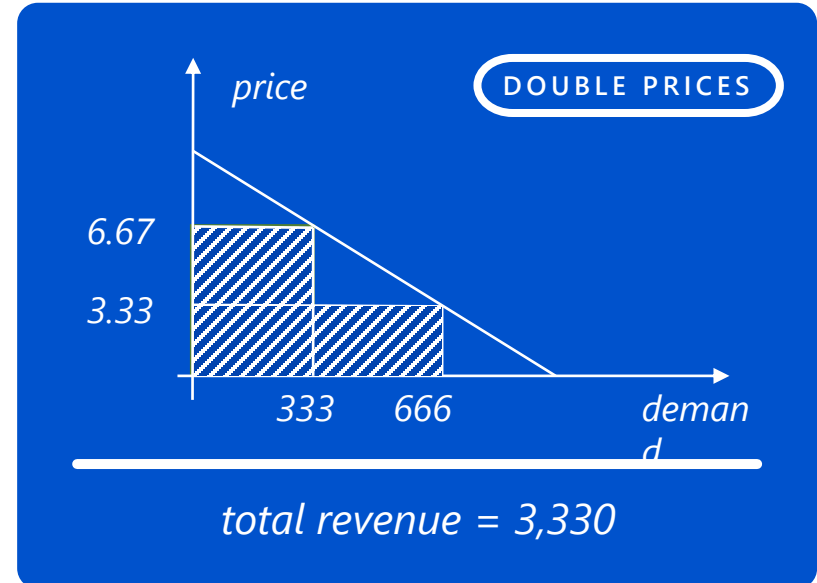
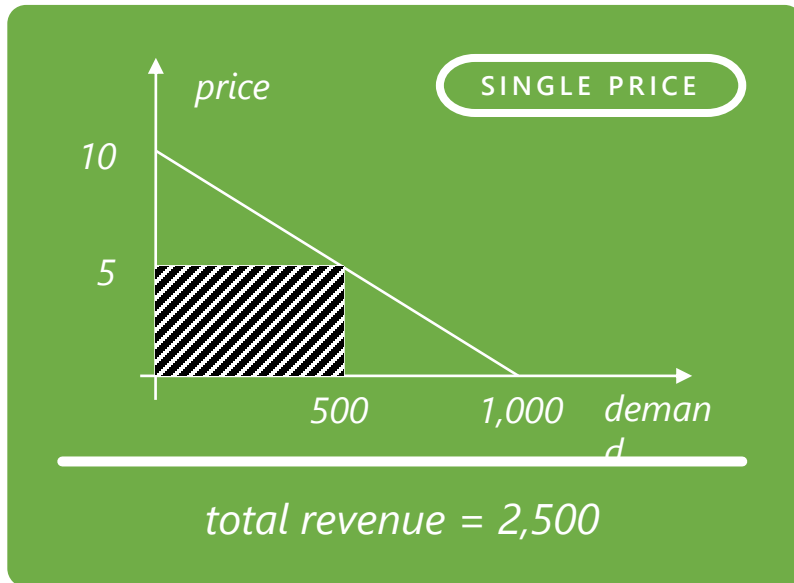


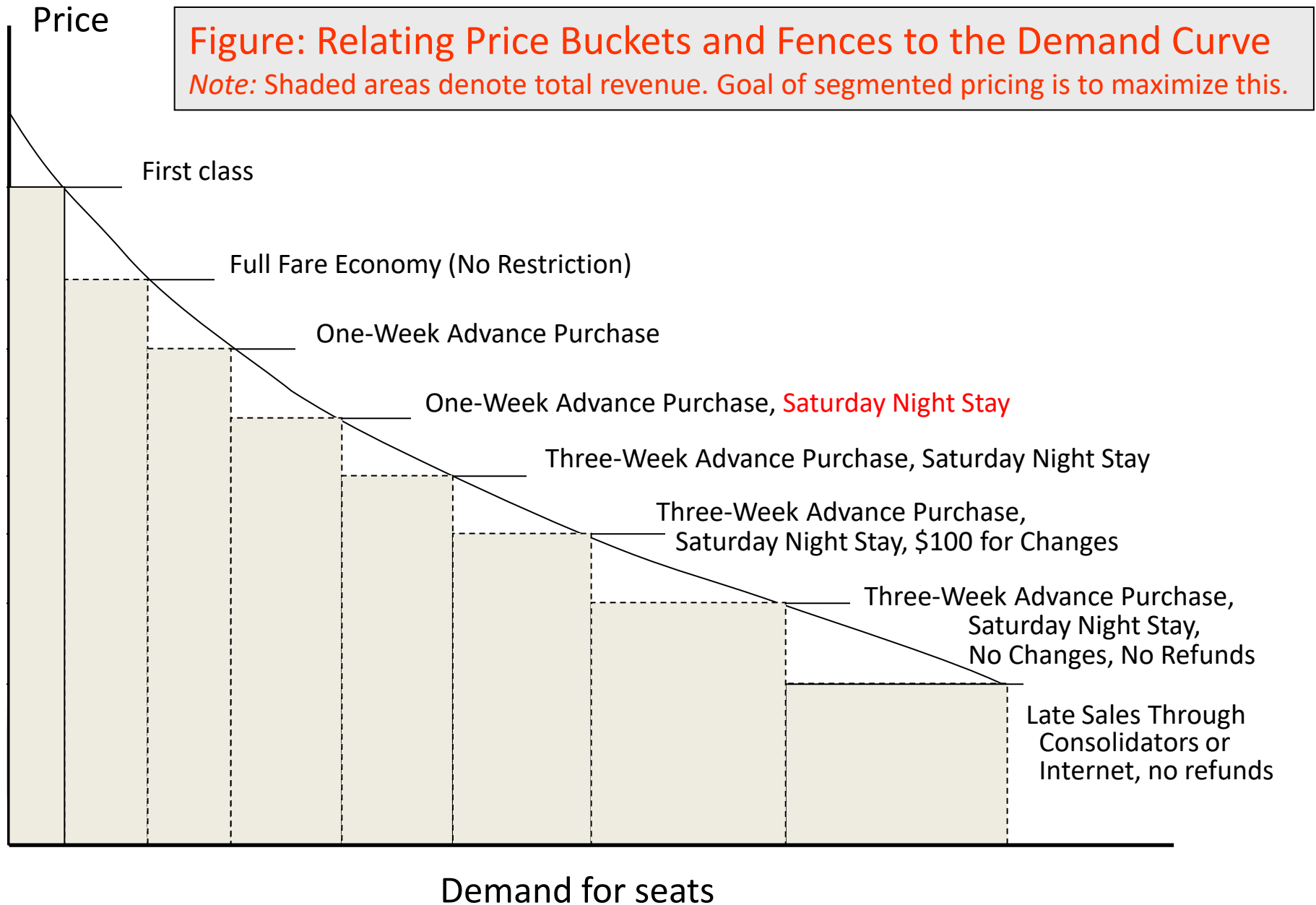
Price Discrimination – Example

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$$\text{demand} = 1000 - 100 * \text{price}$$

$$\text{revenue} = \text{price} * (1000 - 100 * \text{price})$$





Price Discrimination and Customization

- Other examples
 - Demographics: Age, gender
 - Brand, distribution channel
 - Order volume
 - Location
 - Service (warranty)
 - Look/color
- Ethic considerations
 - Privacy, anti-discrimination, fairness

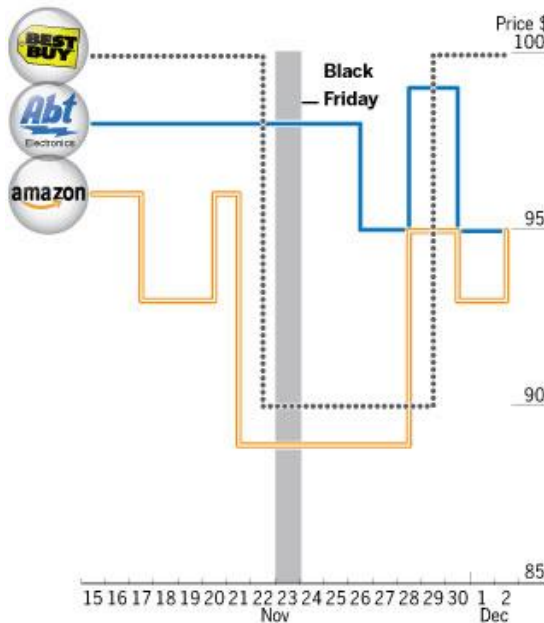
Dynamic Pricing

For a single product, set price dynamically *over time*, and set one price for all the customers.

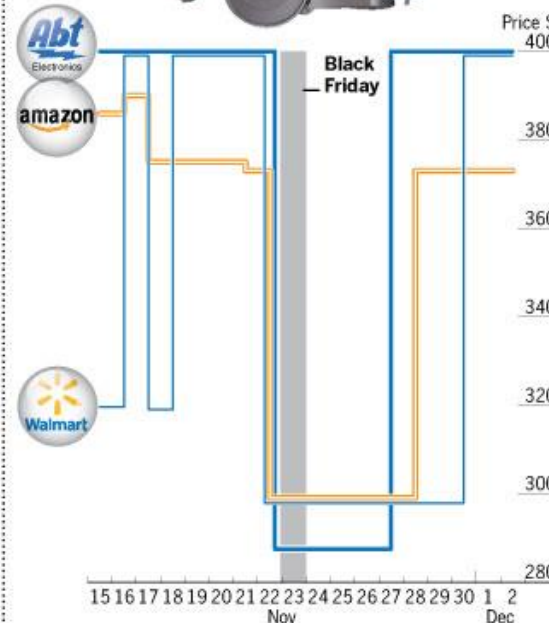
Retailers' pricing Black Friday volatility

Selected retailers

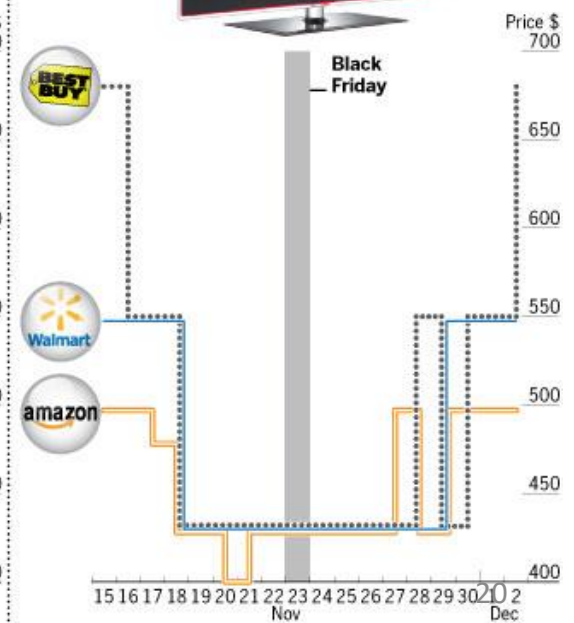
Apple TV



Dyson vacuum cleaner



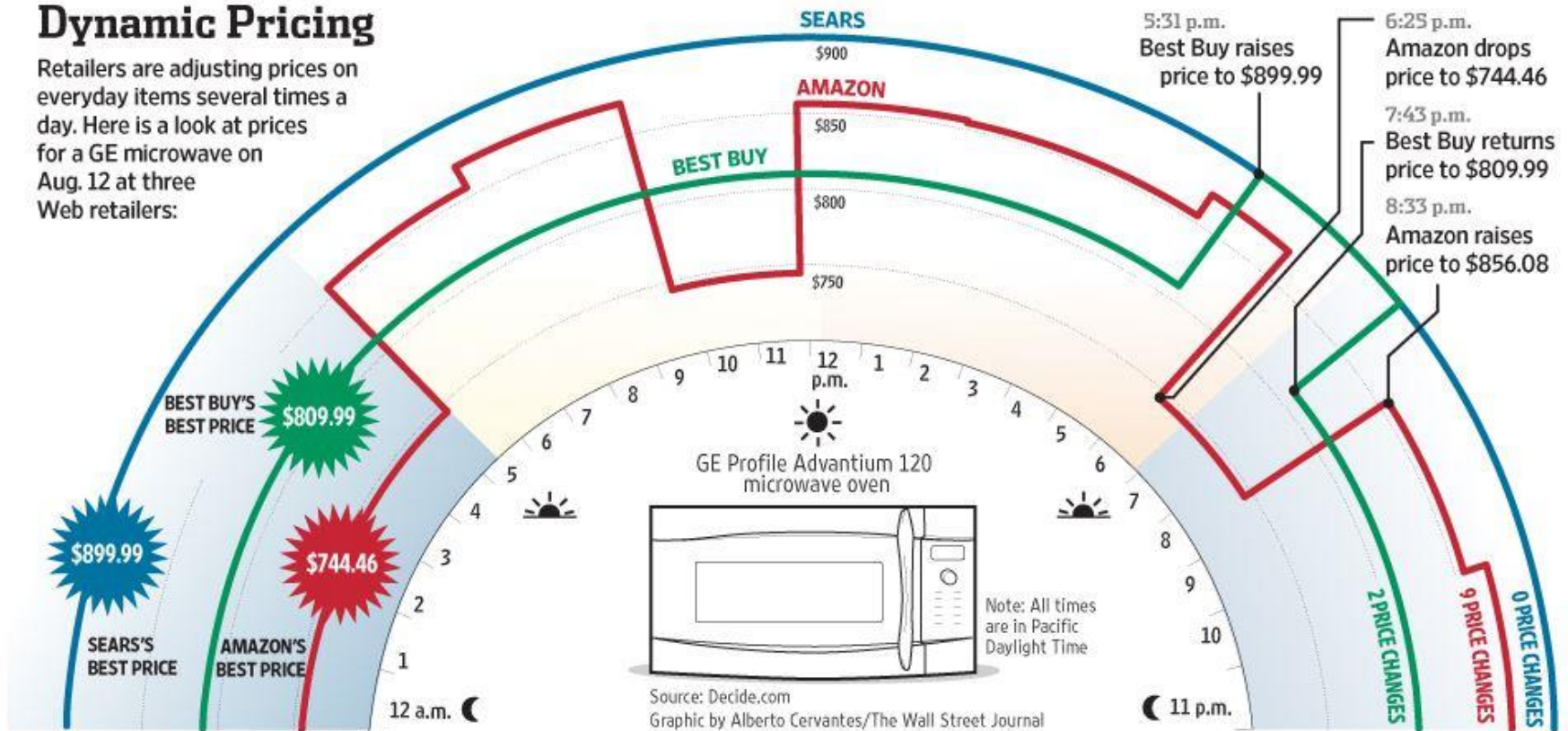
Samsung TV



Dynamic Pricing

Dynamic Pricing

Retailers are adjusting prices on everyday items several times a day. Here is a look at prices for a GE microwave on Aug. 12 at three Web retailers:



Rue La La

RUE LA LA

RUE NOW

WHEN WILL MY ORDER ARRIVE? [DETAILS.](#)



MY ACCOUNT ▾



Search



Rue La La®

BRANDS

WOMEN

MEN

HOME

TRAVEL

KIDS

GIFTS

TODAY'S FIX

COMING SOON

LIMITED-TIME ONLY

special access

to our top brands

SHOP NOW

just for **NEW MEMBERS**

PANDORA™

VALENTINO

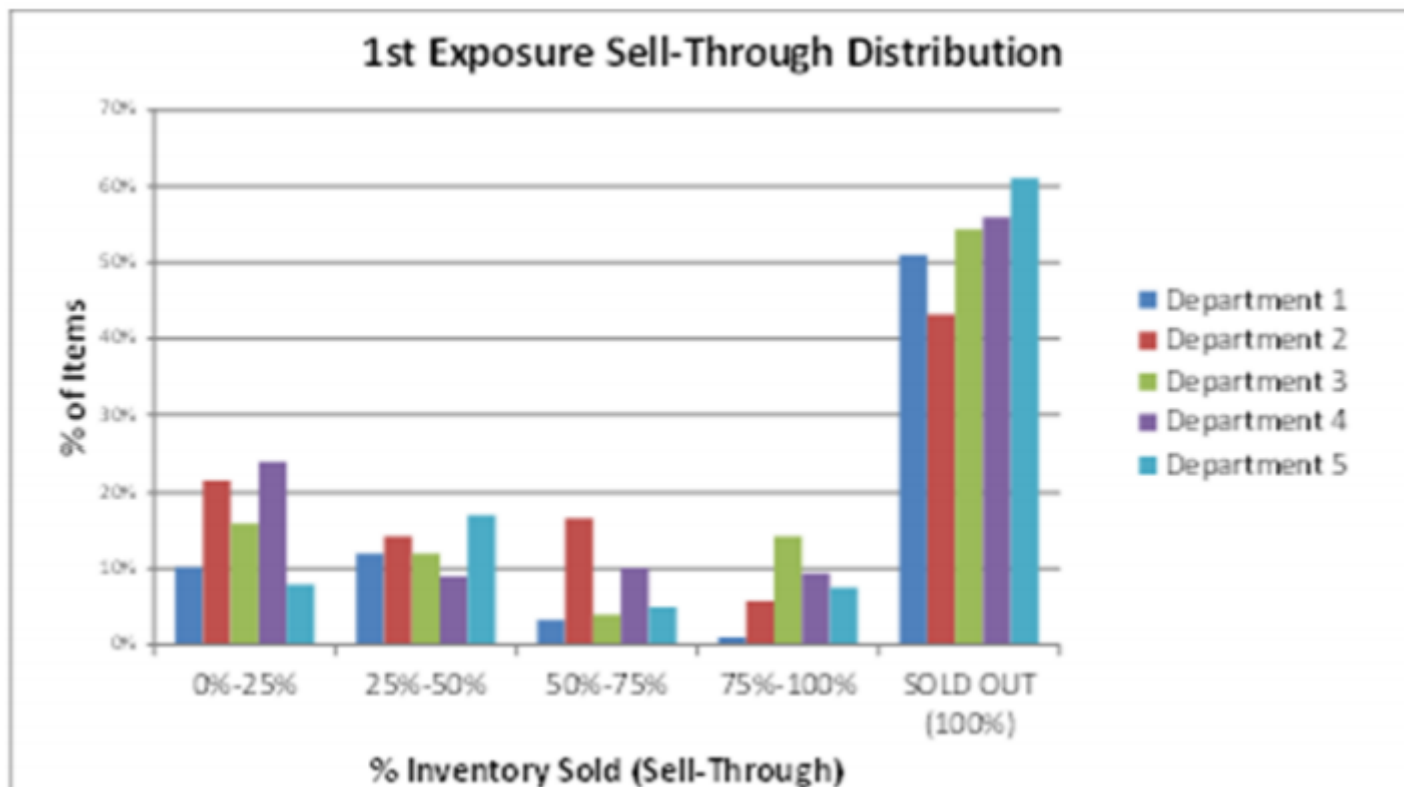
Salvatore Ferragamo

LOUIS VUITTON

Ray-Ban

Rue La La

- Price Optimization for first time offerings
 - Result: Overall 10% increase in total revenue



Revenue management

- Price Control
 - Price customization
 - Dynamic pricing
- Capacity Control
 - Yield management
 - Service customization

Reserving Capacity

- You manage a hotel with 200 rooms in Indianapolis, IN. The NCAA Championship Game is coming up. Sports fans either book a room in advance or wait until the last minute.
 - Advance booking: Bargain rate
 - Late booking: Premium rate
- Suppose you can easily get 200 advance reservations and fill up your hotel.
 - Should you fill up rooms with advance customers? Why?
 - How many rooms should be set aside for last-minute customers? What information do you need?



The Classic Newsvendor Model

- A newsvendor stocks newspapers to sell that day
- Trade-offs:
 - If stocks too few newspapers, missing potential sales.
 - If stocks too many newspaper wasted on unsold newspapers.



How many newspapers should be stocked?

The Classic Newsvendor Model

Newsvendor Model

- A decision-making framework for Single period inventory decision.
- Uncertain Demand: Demand is random and follows a probability distribution.
- Perishable Inventory: Products are perishable or have a limited shelf life.
- Overage cost c_o (cost of ordering too much) versus Underage cost c_u (cost of ordering too little).
- Objective: Determine the optimal order quantity to minimize expected cost.

Solution

- Critical Ratio (CR): $C_u / (C_o + C_u)$
- Optimal order quantity Q^* satisfies $P(\text{Demand} \leq Q^*) = CR$

Reserving Capacity and Newsvendor

Room Reservation	Newsvendor Problem
Hotel rooms are “perishable”	Newspapers are “perishable”
Random last-minute demand	Random newspaper demand
Decide how many rooms to reserve for last-minute customers	Decide how many newspapers to purchase
If reserve too few rooms, miss potential premium customers	If stock too few newspapers, miss potential sales
If reserve too many rooms, revenue lost on empty rooms	If stock too many newspapers, money wasted on unsold newspapers

Reserving Capacity

- Assume
 - Number of last-minute customers is normally distributed with mean 75 and st dev 25
 - Advance booking: \$200/night
 - Late booking: \$500/night
- How many rooms should be set aside for last-minute customers?

$$C_u = \frac{\$500 - \$200}{\$200} = \$300$$

$$C_o = \frac{\$200}{\$300}$$

$$\text{Critical ratio} = 300 / (200+300) = 0.6 \quad z = 0.25$$

Should reserve 82 rooms for last-minute customers
($75 + 0.25 * 25 = 81.25$, round up)

Overbooking

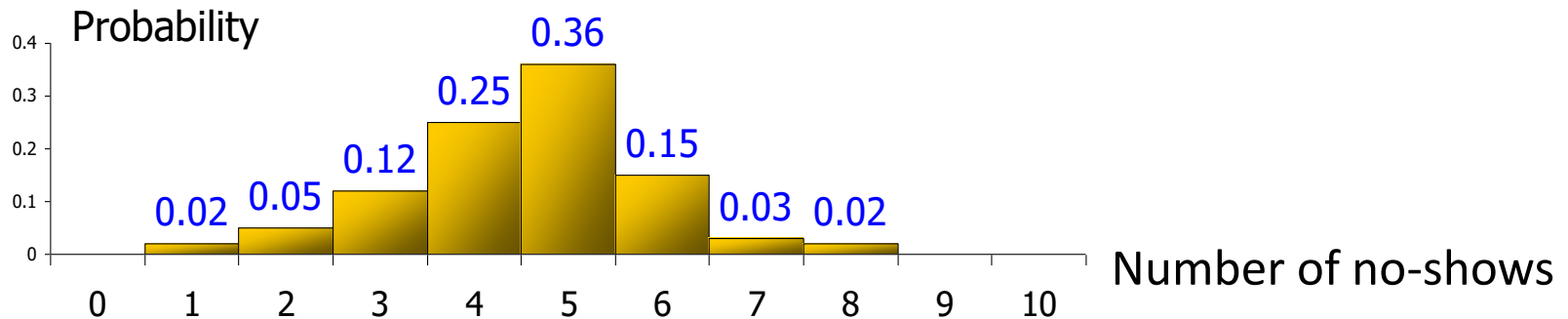
- Suppose you cannot charge latecomers a different rate because of a city ordinance that prohibits “price gouging” during the Final Four weekend
- You can easily get 200 reservations and fill up your hotel
- But you are afraid that some people with reservations may not show up
- How many reservations should you take?
 - More than 200?
 - How many more?
 - What information do you need?

Overbooking and Newsvendor

Overbooking	Newsvendor Problem
Overbooks are “perishable”	Newspapers are “perishable”
Random no-shows	Random newspaper demand
Decide how many overbooks	Decide how many newspapers to purchase
If too few overbooks, miss potential sales	If stock too few newspapers, miss potential sales
If too many overbooks, incur loss of good-will	If stock too many newspapers, money wasted on unsold newspapers

Overbooking

- Assume
 - The number of no-shows is distributed as follows:



- Room rate is \$200 per night
- It costs the hotel \$500 per night to book a room in a nearby hotel for an overbooked customer
- How many overbooks should you take?

$C_u =$ _____

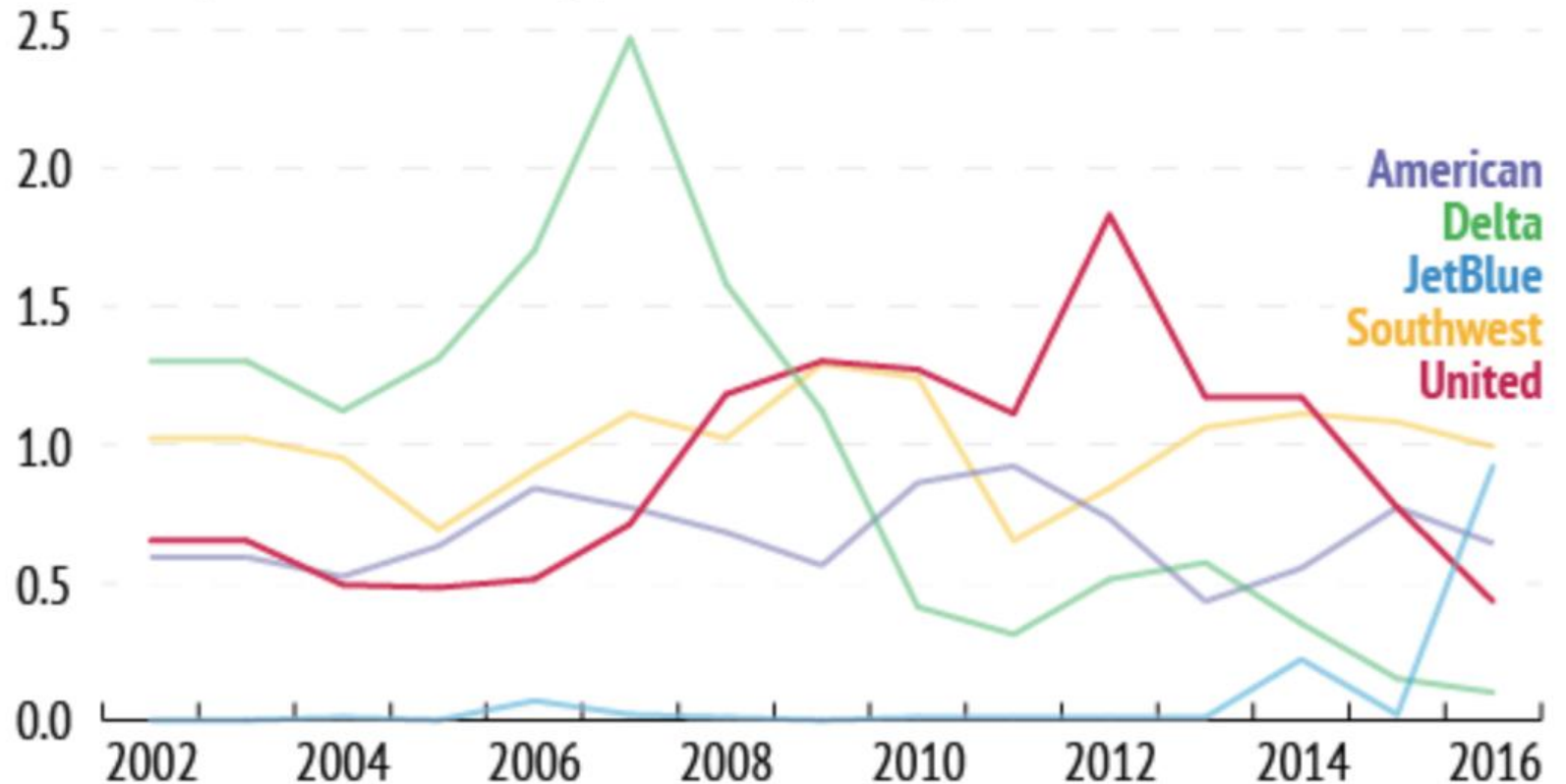
$C_o =$ _____

Critical ratio =
Should overbook

Overbooking

Leave your seats

Involuntary denials of boarding per 10,000 passengers for select airlines



Source: U.S. Department of Transportation

CNBC

When Overbooking Goes Wrong... +++



Travel » Aviation | Business Traveller | Destinations | Features | Food/Drink | Hotels | Partner Hotels

International Edition + 🔍 ☰

Passenger dragged off overbooked United flight



By **Christina Zdanowicz** and **Emanuella Grinberg**, CNN

🕒 Updated 0658 GMT (1458 HKT) April 11, 2017



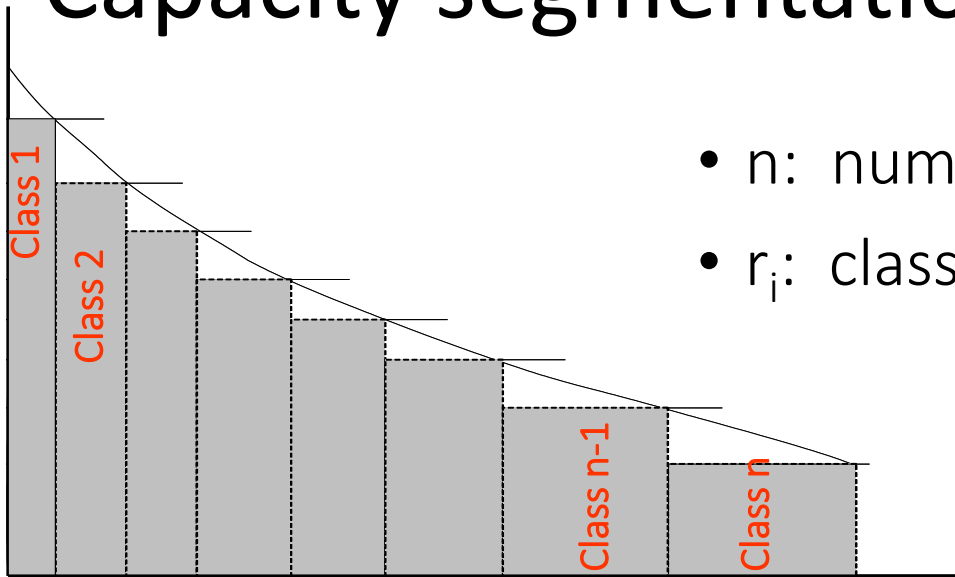
EXAMPLE – FLIGHT UA3411

- April 9, 2017, UA3411 from Chicago O'Hare to Louisville
- The plane was full, and everyone had boarded
- 4 crew members needed to fly to Louisville to work on a flight departing later from Louisville
- United asked for 4 volunteers
- Not enough volunteered despite increased perks, so UA subsequently randomly picked a passenger to deboard
- The passenger refused and....
- Can this incident change how airlines approach overbooking?



When Overbooking Goes Wrong...

Capacity segmentation and allocation



- n : number of fare classes ($n > 2$)
- r_i : class- i fare ($r_1 > r_2 > \dots > r_n$)

total number of available aircraft seats

Protection level for $n-1$ and lower

b_n

Protection for $n-2$ and lower

b_{n-1}

b_2

b_1

nested
booking limits



These fares do not include government fees and taxes.

Flights	Departs	Arrives	Stops	More Fares → <u>Refundable Anytime</u> \$146	→ <u>Restricted Fares</u> \$133	→ <u>Advance Purchase</u> \$118	→ End <u>Fun Fares</u> \$104
2510	6:40am	8:45am	N/S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
593	10:40am	12:45pm	N/S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1577/2126	12:55pm	4:00pm	RNO/I	<input type="radio"/>	<input type="radio"/>	Unavailable	Unavailable
1066	5:20pm	7:25pm	N/S	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

These fares do not include government fees and taxes.

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2510	6:40am	8:45am	N/S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
593	10:40am	12:45pm	N/S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unavailable
1577/2126	12:55pm	4:00pm	RNO/I	<input type="radio"/>	<input type="radio"/>	Unavailable	Unavailable	Unavailable
1066	5:20pm	7:25pm	N/S	<input type="radio"/>	<input type="radio"/>	Unavailable	Unavailable	Unavailable

6 days later

These fares do not include government fees and taxes.

Flights	Departs	Arrives	Stops	More Fares → <u>Refundable Anytime</u> \$146	→ <u>Restricted Fares</u> \$133	→ <u>Advance Purchase</u> \$118	→ <u>Fun Fares</u> \$104	→ End <u>Internet One-way</u> \$69
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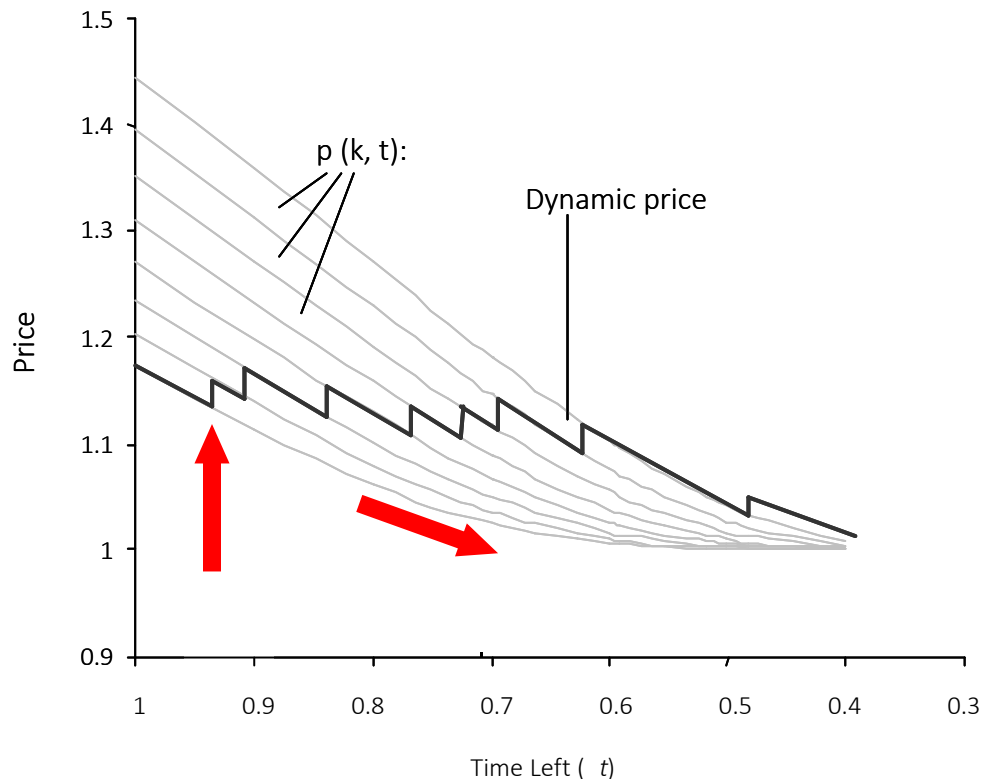
9 days later

These fares do not include government fees and taxes.

Flights	Departs	Arrives	Stops	More Fares → <u>Refundable Anytime</u> \$146	→ <u>Restricted Fares</u> \$133	→ <u>Advance Purchase</u> \$118	→ <u>Fun Fares</u> \$104	→ End <u>Internet One-way</u> \$69
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1066	5:20pm	7:25pm	N/S	<input type="radio"/>	<input type="radio"/>	Unavailable	Unavailable	Unavailable

12 days later

Typical Pricing Curves



Three deciding factors:

- How many items are left, k
- How much time is left, t
- How demand will change

- As the number of remaining items decreases, price increases (price is higher if there are fewer items to sell)

- As time goes by, price decreases (price is higher if there is more time left to sell)

- As demand increases / decreases, so does the price

So, Revenue Management...

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DEMAND MANAGEMENT



Segmentation



Pricing



NEW TRICKS



Tactical applications of various concepts



Systematic/disciplined approaches



Data/IS-intensive nature

Challenges?



CHALLENGES

DATA

source of demand information



Data collection

MSBA7012 Social Media & Digital Marketing Analytics



Forecasting

MSBA7013 Forecasting and Predictive Analytics



Real-time updates

MSBA7021 Prescriptive Analytics

ANALYTICAL MODELS



Capable of deciding

both pricing and capacity



Providing status updates



Dynamic programming required

Thank You

Huiyin Ouyang
oyhy@hku.hku

