



Question

How to optimize pricing and product availability?

Demand Forecasting

Four Core Concepts of RM

Overselling

Section 1

The Three Laws of Forecasting

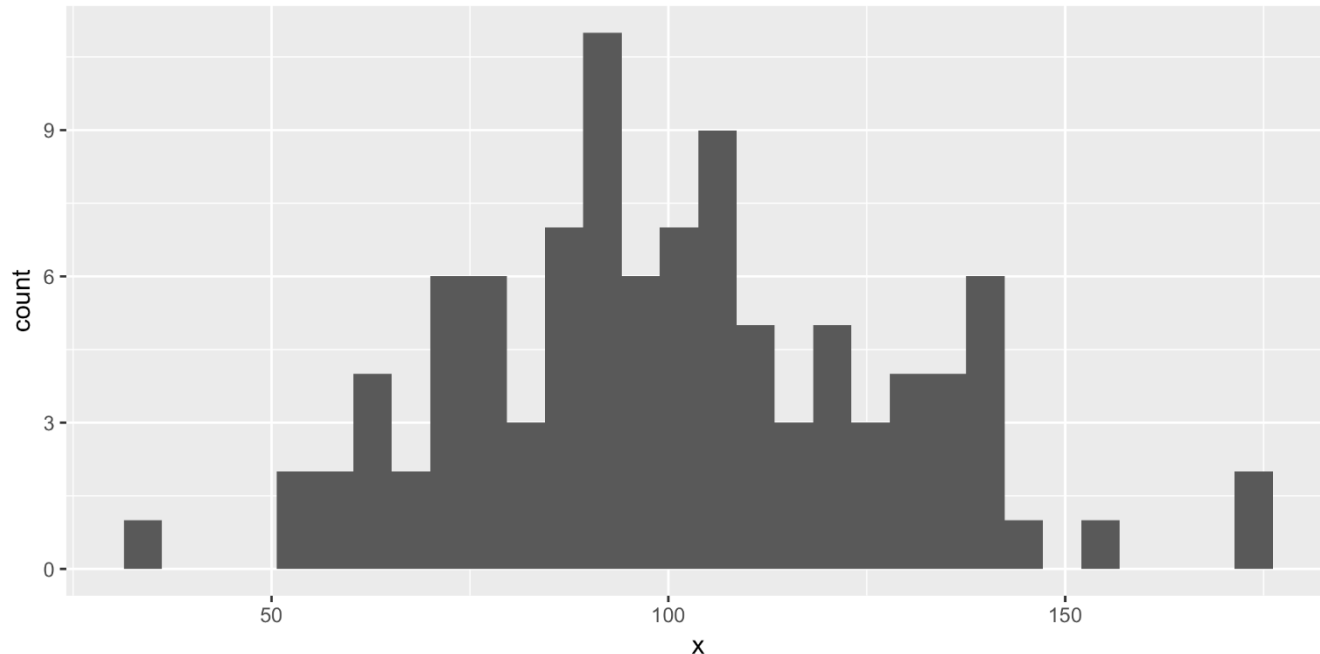
The three laws of forecasting

1. The forecast is always wrong
2. The shorter the forecast horizon, the more accurate the forecast
3. Aggregate forecasts are more accurate than individual forecasts

Law #1: The forecast is always wrong

Principle It is very difficult to predict the demand exactly!

Example Normally distributed demand with mean = 100, standard deviation = 30



It is costly to ignore demand variability

Consider the following example:

- A-1 Bakery sells donuts (cost = \$8, price = \$10, salvage = \$0)
- Daily demand is normal (mean = 100, sd = 30)
- The order quantity determines the expected profit
 - Order $q = 100$ (mean) \Rightarrow expected profit = \$80
 - Order $q^* = 75$ (optimal) \Rightarrow expected profit = \$115 **profit increases by > 40%**

Law #2: Shorter forecast horizon \Rightarrow better forecast

Principle A short-term forecast is more accurate than a long-term forecast

Example Which is easier to predict?

- A. The weather / sales tomorrow (day $t = 1$)
- B. The weather / sales in 6 months (day $t = 180$)

Reason Long-term forecasts are noisy because of many uncertainties

How Zara benefits from the 2nd law of forecasting

Zara is a fast-fashion retailer

Production lead time (PLT) =

Time from design to production to sale

Zara uses supply chain speed as a strategic business weapon

- PLT for H&M = 6 months
- PLT for Zara = 5 weeks

Short PLT \Rightarrow Better demand forecasts



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Law #3: Aggregate forecasts are more accurate

Principle Forecasts are usually more accurate for groups

- For example: aggregating/grouping across products, time, locations, etc

Example Which is easier to predict?

- A. Sales of blue iPhone XRs with 64 GB storage
- B. Sales of all colors and all storage levels of iPhone XRs

Reason High demand somewhere cancels out low demand somewhere else

What is the coefficient of variation?

The standard deviation (σ) quantifies the amount of variation or dispersion of a set of data values

The coefficient of variation (CV) is defined as the ratio of the standard deviation σ to the mean μ , i.e.,

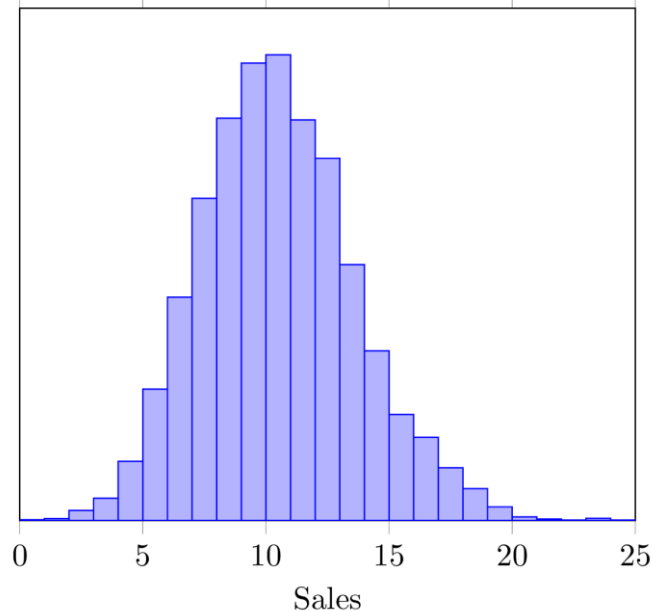
$$CV = \sigma / \mu$$

- Standard deviation measures the absolute variability 500 ± 100
- Coefficient of variation measures the relative variability $500 (1 \pm 20\%)$

Example of individual demand vs aggregate demand

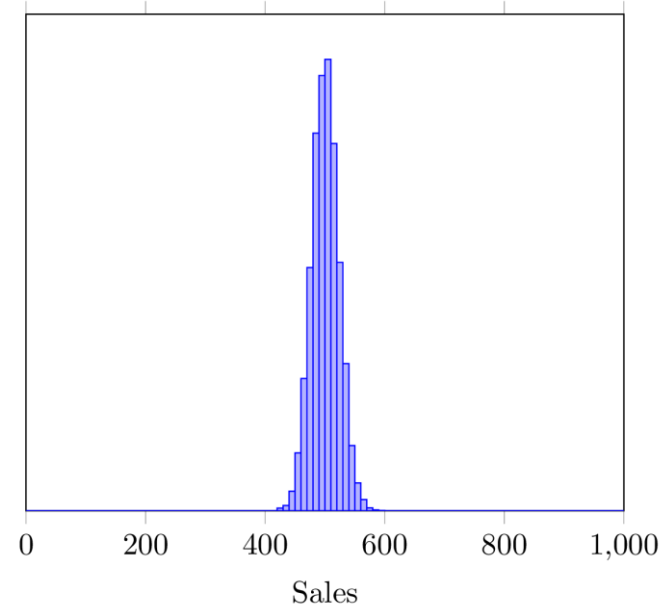
Individual Demand (1 store)

$\mu = 10, \sigma = 3.16, CV = 0.32$



Aggregate Demand (50 stores)

$\mu = 500, \sigma = 22.4, CV = 0.04$



Note: calculations are for illustrative purposes only, you do NOT need to know how to perform these calculations

How Apple benefits from the 3rd law of forecasting

On 12 Sept 2018, Apple announced three new phones

- iPhone XR comes in 6 colors
- iPhone XS and iPhone XS Max comes in 3 colors
- The iPhones also have 3 storage levels

⇒ Hard to predict demand for a (model, color, storage) combination

The three phone models use the **same** system on a chip

⇒ Easy to predict demand for the A12 Bionic

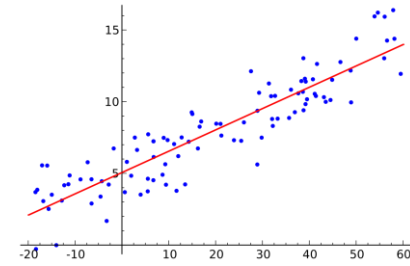


Section 2

Forecasting Methods

Forecasting methods: qualitative vs quantitative

	Qualitative	Quantitative
Relies on	Qualities or characteristics	Quantities or measured values
Relies on	The judgment of “experts”	Statistical models
When to use	Useful in new situations (e.g., new products, markets)	Useful when sufficient historical data is available
Nature	Subjective and inconsistent	Objective and reproducible



Qualitative forecasting method 1: Personal insight

The **personal insight** method relies on a single person using his experience to give a forecast of the future

Weakness Highly subjective

Qualitative forecasting method 2: Panel consensus

Principle Two are better than one... If one falls down the other helps. But if there's no one to help, that's tough! (From Ecclesiastes)

The **panel consensus** method relies on multiple experts sharing information and arriving at an expectation through consensus

Weakness A highly influential expert could manipulate the other experts

Qualitative forecasting method 3: The Delphi method

Principle Forecasts (or decisions) from a **structured** group of individuals are more accurate than those from **unstructured** groups

How it works

- The experts answer **questionnaires** in multiple rounds
- After each round, a **facilitator** provides an **anonymised summary** of the experts' forecasts and reasons from the previous round

Strength Less susceptible to manipulation by an influential expert

Quantitative forecasting methods

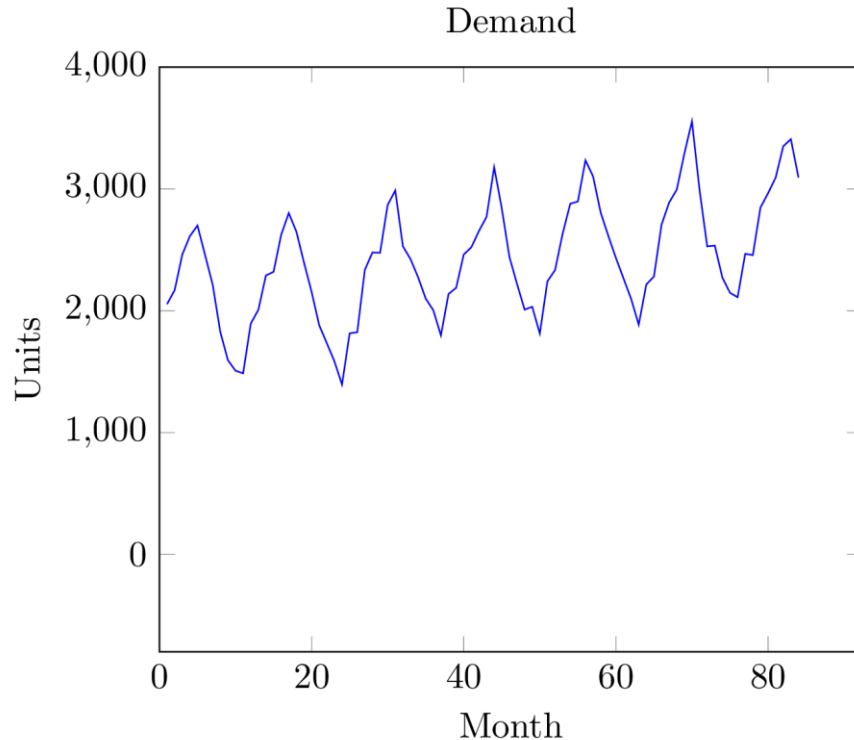
There is much to learn about statistical forecasting methods

- Linear regression
- Logistic regression
- Choice models
- Classification and regression trees (CART)
- And more

We will just give you a **brief taste** of statistical forecasting

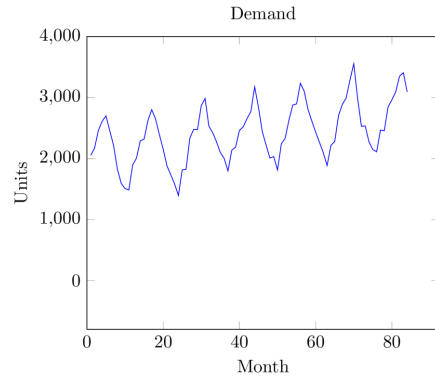
Quantitative forecasting methods

Are there any patterns in the demand plot below?

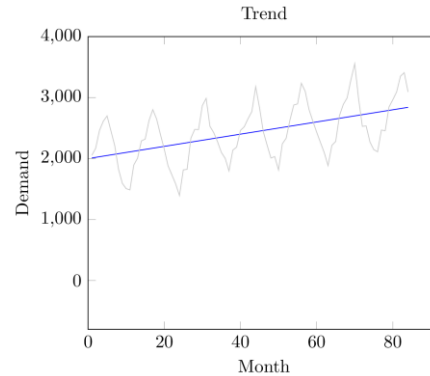


Quantitative forecasting methods

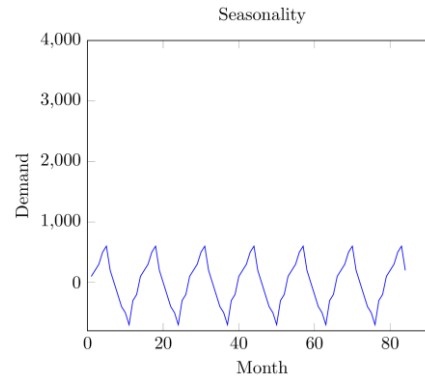
$$\text{Demand} = \text{Trend} + \text{Seasonality} + \text{Shocks}$$



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