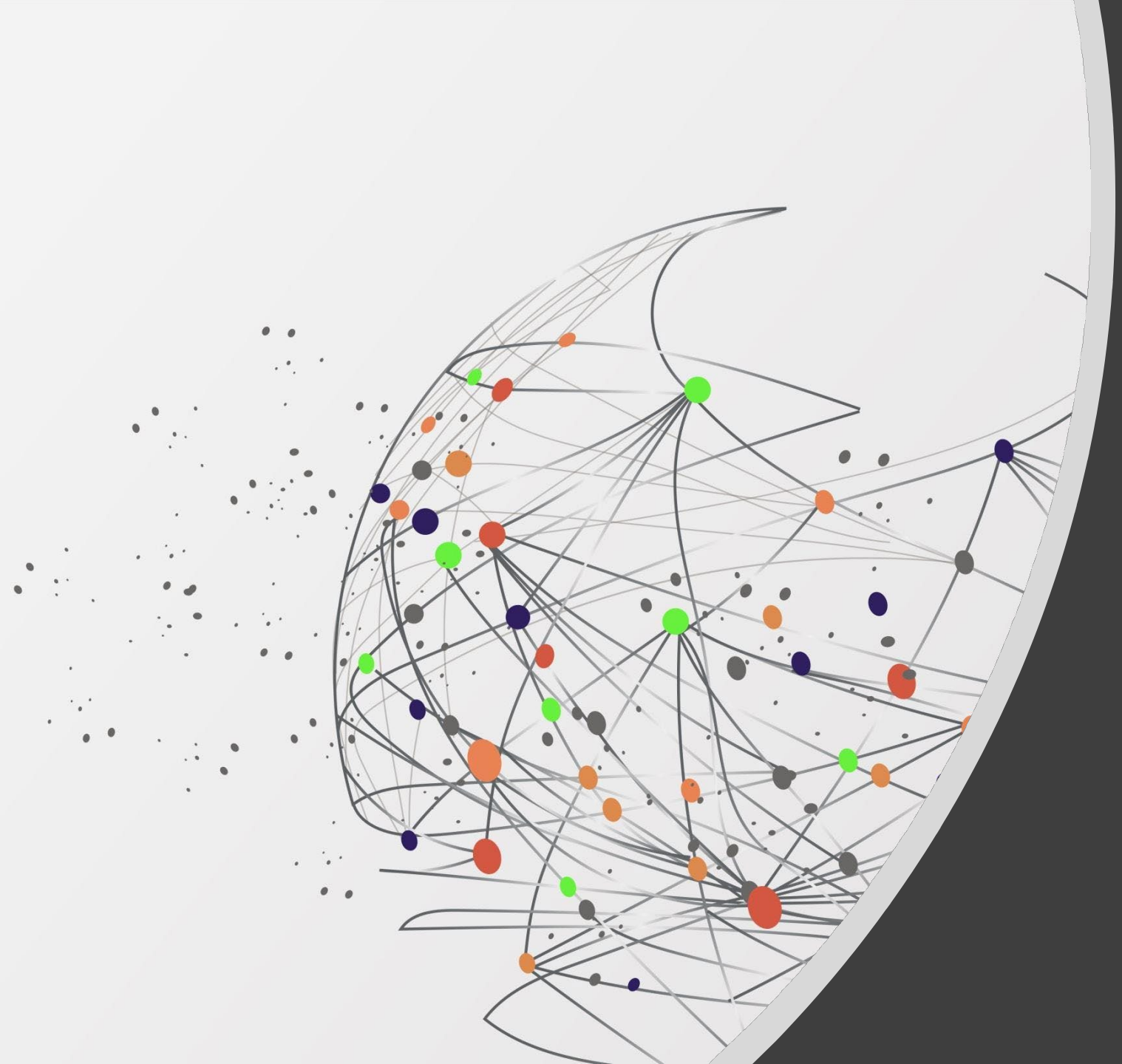


Coordinating Demand & Supply

SCM614

Week 2

Agenda

- Breakout (postponed from week 1) - PP
- Chapter 3: Financial measures of performance
- Case study 7-11 discussion
- Chapter 7: demand forecasting & accuracy with some problems
- Break
- Breakout into teams for next case study
- Summary of upcoming class activities

Examples of Supply Chains

Gateway & Apple

Zara

W.W. Grainger & McMaster-Carr

Toyota

Amazon

Macy’s

Gateway (Acer) and Apple

1. Why did Gateway choose not to carry any finished-product inventory at its retail stores? Why did Apple choose to carry inventory at its stores?
2. What are the characteristics of products that are most suitable to be carried in finished-goods inventory in a retail store? What characterizes products that are best manufactured to order?
3. How does product variety affect the level of inventory a retail store must carry?
4. Is a direct selling supply chain without retail stores always less expensive than a supply chain with retail stores?
5. What factors explain the success of Apple retail and the failure of Gateway Country stores?

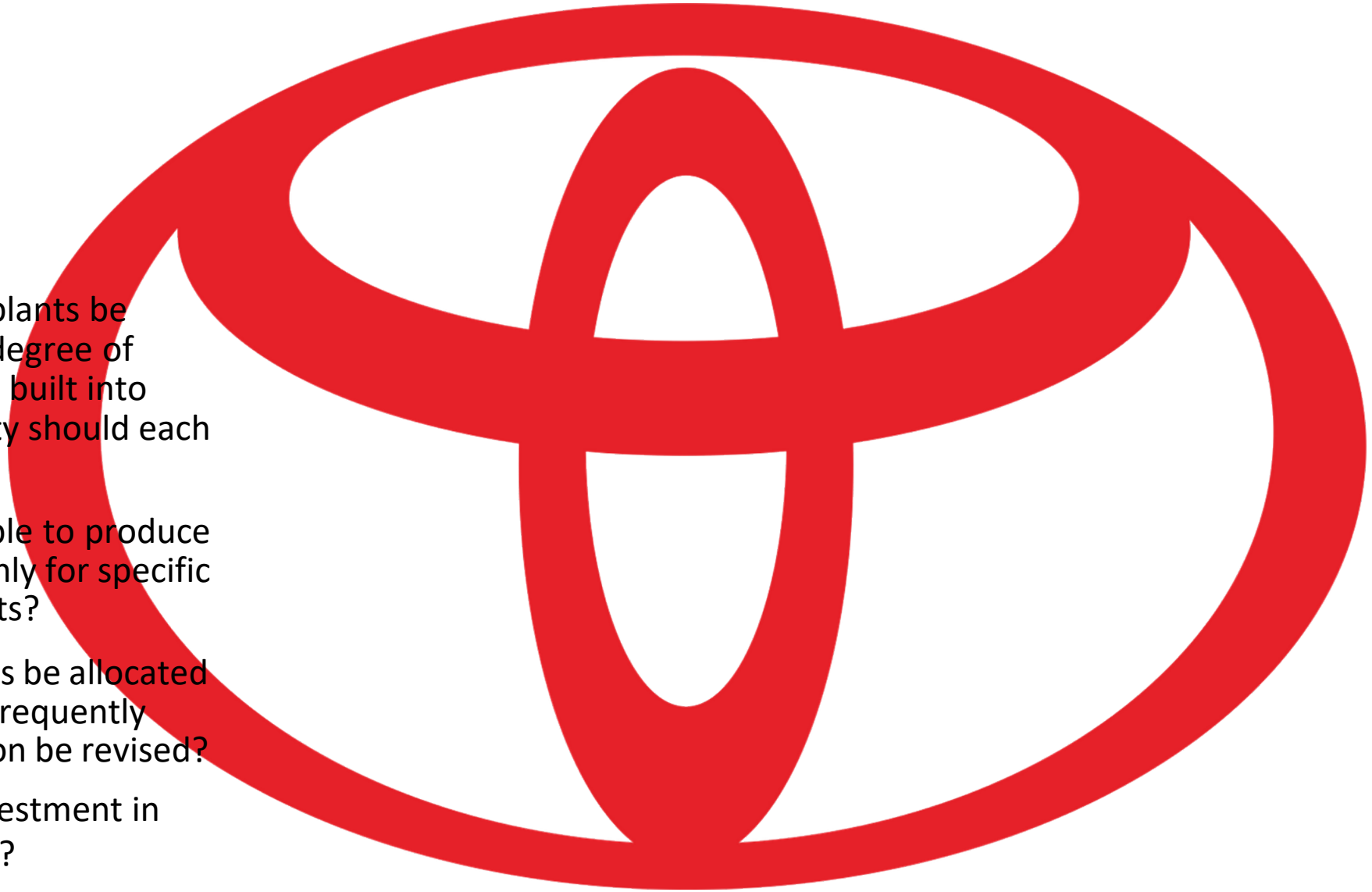
Zara

1. What advantage does Zara gain against the competition by having a very responsive supply chain?
2. Why has Inditex chosen to have both in-house manufacturing and outsourced manufacturing? Why has Inditex maintained manufacturing capacity in Europe even though manufacturing in Asia is much cheaper?
3. Why does Zara source products with uncertain demand from local manufacturers and products with predictable demand from Asian manufacturers?
4. What advantage does Zara gain from replenishing its stores multiple times a week compared to a less frequent schedule?
5. Do you think Zara's responsive replenishment infrastructure is better suited for online sales or retail sales?

W.W. Grainger and McMaster-Carr

1. How many DCs should be built and where should they be located?
2. How should product stocking be managed at the DCs? Should all DCs carry all products?
3. What products should be carried in inventory and what products should be left with the supplier to be shipped directly in response to a customer order?
4. What products should W.W. Grainger carry at a store?
5. How should markets be allocated to DCs in terms of order fulfillment? What should be done if an order cannot be completely filled from a DC? Should there be specified backup locations? How should they be selected?

Toyota



1. Where should the plants be located, and what degree of flexibility should be built into each? What capacity should each plant have?
2. Should plants be able to produce for all markets or only for specific contingency markets?
3. How should markets be allocated to plants and how frequently should this allocation be revised?
4. How should the investment in flexibility be valued?

Amazon

1. Why is Amazon building more warehouses as it grows?How many warehouses should it have, and where should they be located?
2. Should Amazon stock every product it sells?
3. What advantage can online players derive from settingup a brick-and-mortar location? How should they use the two channels to gain maximum advantage?
4. What advantages and disadvantages does the online channel enjoy in the sale of shoes and diapers relativeto a retail store?
5. For what products does the online channel offer thegreater advantage relative to retail stores? What characterizes these products?

Macy's and W.W. Grainger

1. Should online orders be filled from stores or fulfillment centers? What role(s) should eachfacility play?
2. How should store inventories be managed in an omni-channel setting?
3. Should returns be kept at a store or sent to a fulfillment center?

Group breakout instructions

- For your assigned company(ies), do a quick investigation of the supply chain(s)
- Answer the questions posed considering:
  - Where to locate facilities? How to size them?
  - Where is the push/pull boundary?
  - What modes of transport to use?
  - How much inventory to carry? In what form?
  - Where to source from?

These are in Content/Module 1/Week 1/lecture/SCM614 week1 breakout

https://www.etsy.com/hk-en/listing/555248235/break-dance-clipart-vector-svg-break

Chapter 3: Financial Measures of Performance

(1 of 3)

- From a shareholder perspective, return on equity (ROE) is the main summary measure of a firm's performance

$$\text{ROE} = \frac{\text{Net Income}}{\text{Average Shareholder Equity}}$$

https://www.pymnts.com/news/fintech-investments/2018/goldman-sachs-buys-personal-finance-app-clarity-money-marcus/

- Return on assets (ROA) measures the return earned on each dollar invested by the firm in assets

$$\text{ROA} = \frac{\text{Earnings before interest}}{\text{Average Total Assets}}$$

$$= \frac{\text{Net Income} + [\text{Interest Expense} \times (1 - \text{Tax Rate})]}{\text{Average Total Assets}}$$

$$\text{ROA} = \frac{\text{Earnings before interest}}{\text{Sales Revenu}} \times \text{SalesRe}$$

$$= \text{Pro}$$

ROA can be written as the product of two ratios – profit margin and asset turnover

Financial Measures of Performance (2 of 3)

- An important ratio that defines financial leverage is accounts payable turnover (APT)

$$\textbf{APT} = \frac{\textbf{Cost of Goods Sold}}{\textbf{Accounts Payable}}$$

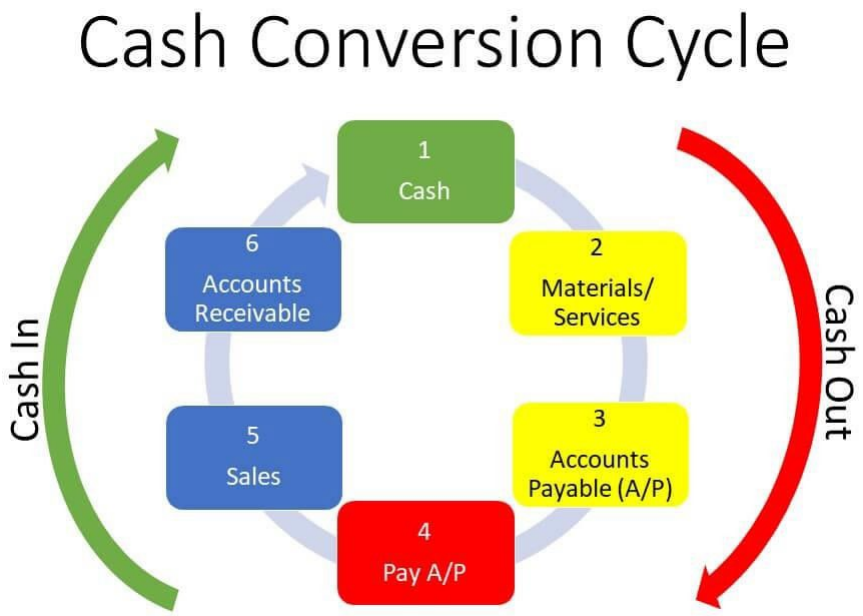
- Key components of asset turnover are accounts receivable turnover (ART); inventory turnover (INVT); and property, plant, and equipment turnover (PsonET)

$$\textbf{ART} = \frac{\textbf{Sales Revenue}}{\textbf{Accounts Receivable}}; \quad \textbf{INVT} = \frac{\textbf{Cost of Goods sold}}{\textbf{Inventories}};$$

$$\textbf{PPET} = \frac{\textbf{Sales Revenue}}{\textbf{PP \& E}}$$

Financial Measures of Performance (3 of 3)

- Cash-to-cash (C2C) cycle roughly measures the average amount time from when cash enters the process as cost to when it returns as collected revenue



$$C2C = -\text{Weeks Payable}\left(\frac{1}{APT}\right) + \text{Weeks in Inventory}\left(\frac{1}{INVT}\right) + \text{Weeks Receivable}\left(\frac{1}{ART}\right)$$

https://cfoperspective.com/free-your-cash-trapped-in-the-cash-conversion-cycle/

7-Eleven Case study

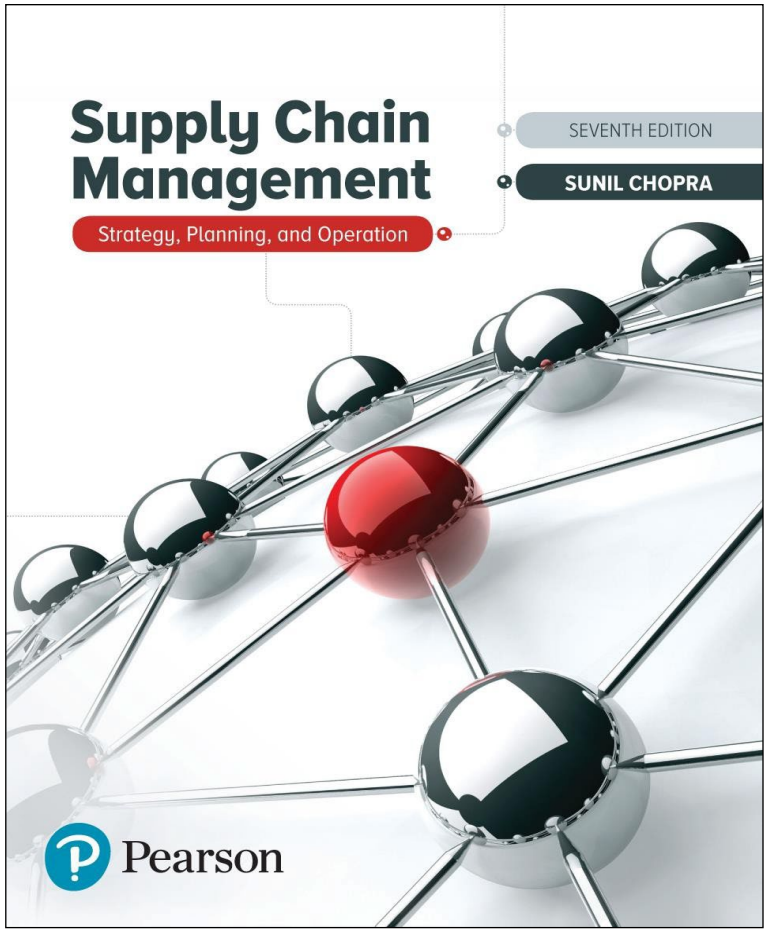
- What was the most surprising thing you learned in this study?
- What is the strategy of 7-11 Japan?
- How does the distribution network of 7-11 Japan support its strategy?
- What came first: the strategy or the distribution model?
- Could this work in the US?
- How does 7-11 balance responsiveness, cost, and risks?
- Multi-use locations: food, consumer products, parcel pick up, pay bills, buy concert tickets. Some have gathering places for seniors. How to carve up space?

A 7-Eleven clerk at a store in Tokyo stocks one of the food shelves. (Gary Ambrose / For The Times)

https://www.latimes.com/sports/olympics/story/2021-08-07/7-elevens-convenience-stores-tokyo-japan-olympics

Supply Chain Management: Strategy, Planning, and Operation

Seventh Edition



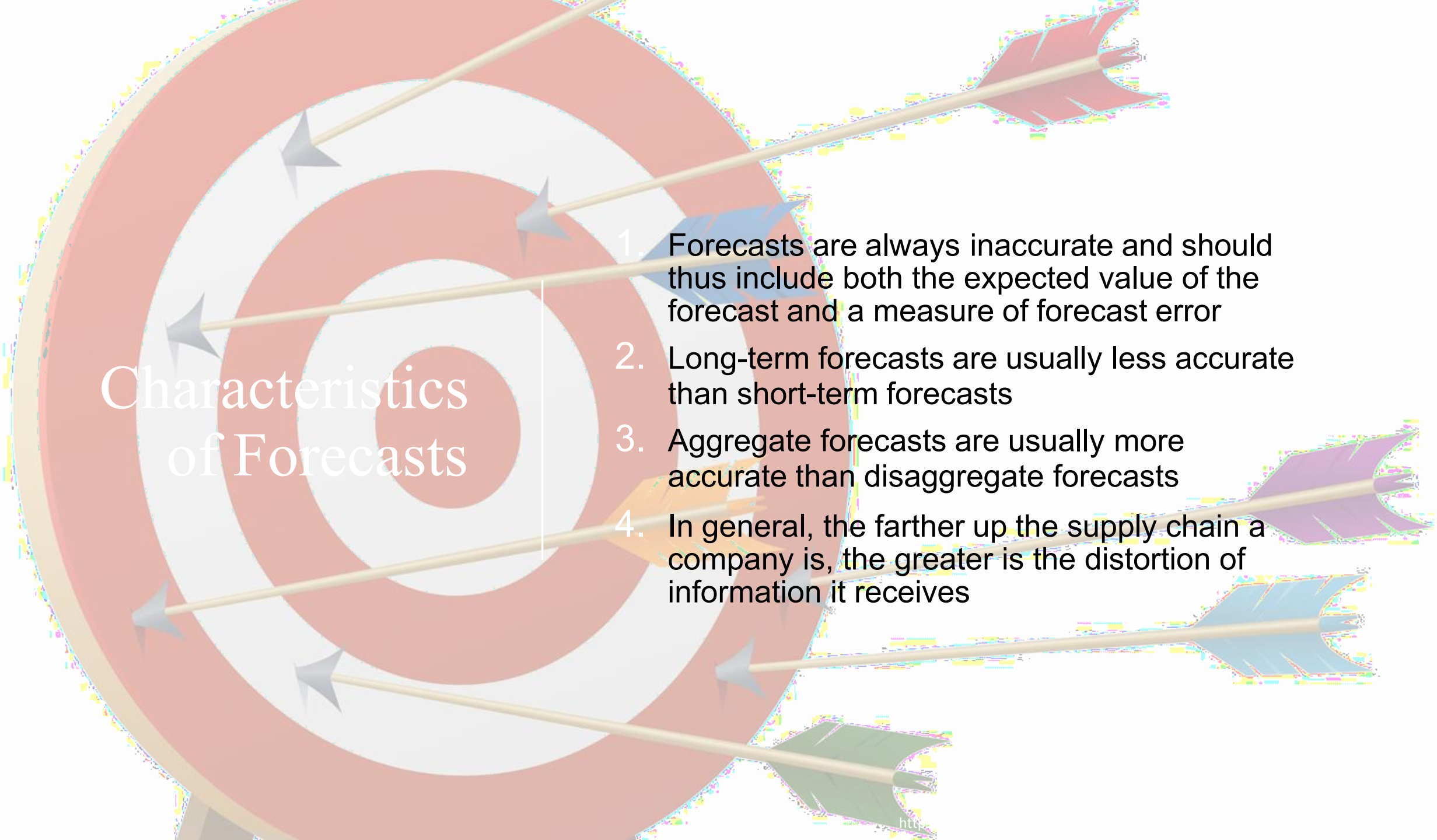
Chapter 7

Demand Forecasting in a Supply Chain

Role of Forecasting in a Supply Chain

- The basis for all planning decisions in a supply chain
- Used for both push and pull processes
  - Production scheduling, inventory, aggregate planning
  - Sales force allocation, promotions, new production introduction
  - Plant/equipment investment, budgetary planning
  - Workforce planning, hiring, layoffs
- All of these decisions are interrelated

https://www.suretysystems.com/



Characteristics of Forecasts

1. Forecasts are always inaccurate and should thus include both the expected value of the forecast and a measure of forecast error
2. Long-term forecasts are usually less accurate than short-term forecasts
3. Aggregate forecasts are usually more accurate than disaggregate forecasts
4. In general, the farther up the supply chain a company is, the greater is the distortion of information it receives

Components and Methods (1 of 2)

- Companies must identify the factors that influence future demand and then ascertain the relationship between these factors and future demand
  - Past demand
  - Lead time of product replenishment
  - Planned advertising or marketing efforts
  - Planned price discounts
  - State of the economy
  - Actions that competitors have taken

https://tradingeconomics.com/commodity/orange-juice

Components and Methods (2 of 2)

- Qualitative
  - Primarily subjective
  - Rely on judgment
- Time Series
  - Use historical demand only
  - Best with stable demand
- Causal
  - Relationship between demand and some other factor
- Simulation
  - Imitate consumer choices that give rise to demand

Delphic tripod. Paestan red-figured bell-krater, ca. 330 BC., British Museum collections

Components of An Observation

Observed demand (O) = systematic component (S) + random component (R)

- **Systematic component** – expected value of demand
  - **Level** (current deseasonalized demand)
  - **Trend** (growth or decline in demand)
  - **Seasonality** (predictable seasonal fluctuation)
- **Random component** – part of forecast that deviates from systematic part
- **Forecast error** – difference between forecast and actual demand

From: US Department of Commerce, International Trade Division

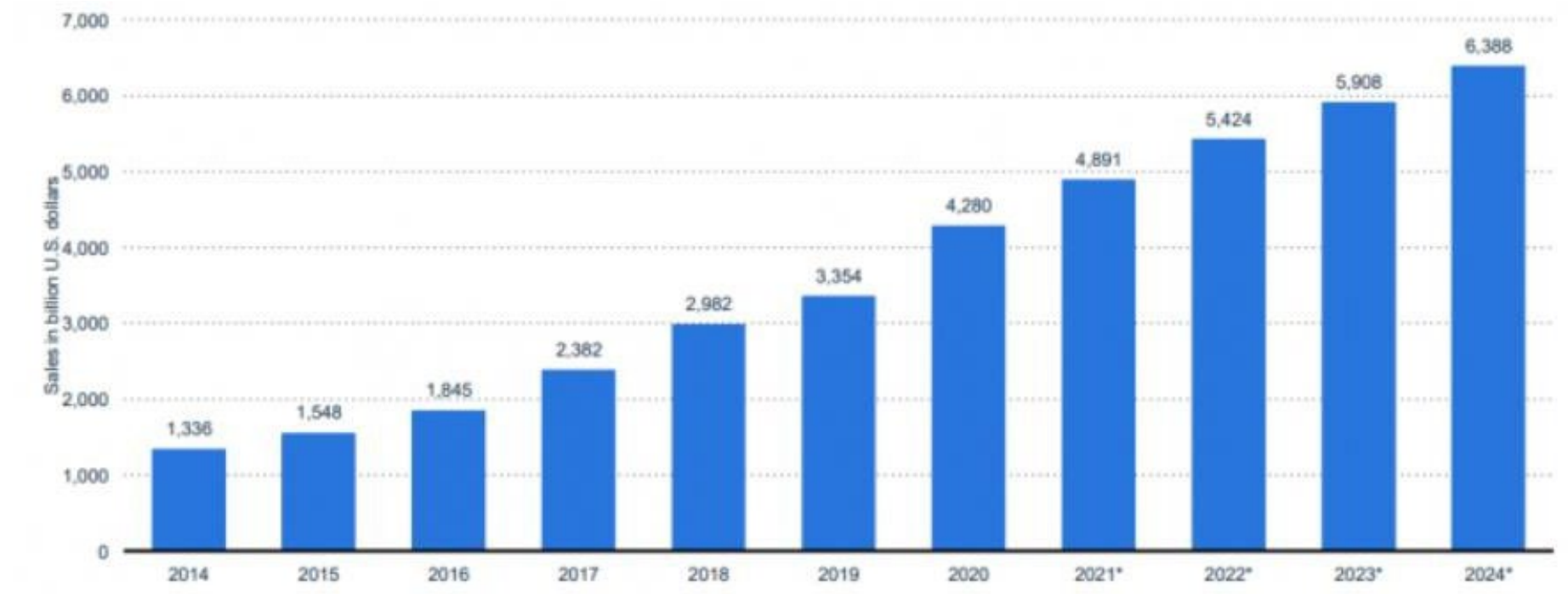


CHART: Global retail ecommerce sales worldwide from 2014 to 2024 (in billion USD)

https://www.trade.gov/ecommerce-sales-size-forecast

U.S. retail e-commerce sales for the second quarter of 2020 totaled $200.7 billion, an increase of 37.0 percent (±1.2%) from the first quarter of 2020

Times-Series Forecasting: static

- Assumes estimates of level, trend, seasonality do not vary with new demand points
- Use the same for all future time periods (we do not go back and recalculate the FC
- Systematic component = (level + trend) × seasonal factor

$$F_{t+l} = [L + (t +$$

- Where

L = estimate of level at $t = 0$
T = estimate of trend
S_t = estimate of seasonal factor for Period t
D_t = actual demand observed in Period t
F_t = forecast of demand for Period t

Times-Series Forecasting: adaptive

- The estimates of level, trend, and seasonality are updated after each demand observation
- Estimates incorporate all new data that are observed

$$F_{t+1} = (L_t + IT_t)S_{t+1}$$

Where

L_t = estimate of level at the end of Period t
T_t = estimate of trend at the end of Period t
S_t = estimate of seasonal factor for Period t
F_t = forecast of demand for Period t (made Period $t-1$ or earlier)
D_t = actual demand observed in Period t
$E_t = F_t - D_t$ = forecast error in Period t

Times-Series Forecasting - Linear Trend

- A simple data plot can reveal the existence and nature of a trend
- Linear trend equation

$$F_t = a + bt$$

where

F_t = Forecast for period t

a = Value of F_t at $t = 0$

b = Slope of the line

t = Specified number of time periods from $t = 0$

Tahoe Salt example (text - Static)

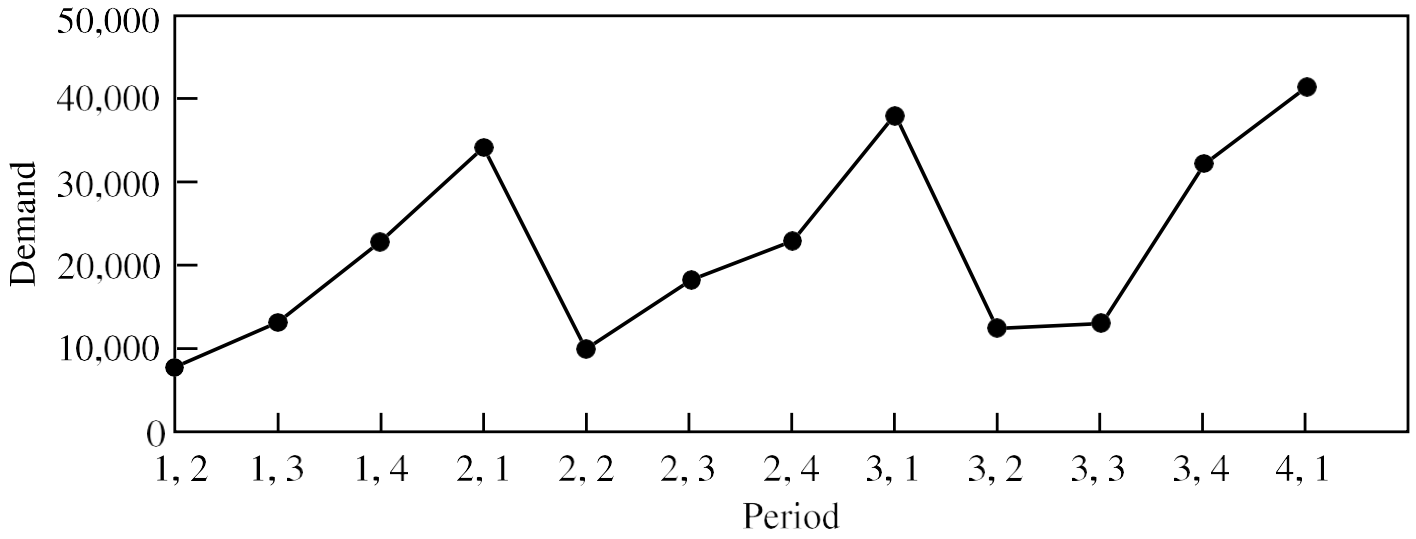


Figure 7-1 Quarterly Demand at Tahoe Salt

1. Deseasonalize demand and run linear regression to estimate level and trend
2. Estimate seasonal factors

Step 1: Deseasonalize

Estimate Level and Trend

Periodicity $p = 4$, $t = 3$

$$\bar{D}_t = \begin{cases} \dfrac{\left[D_{t-\left(\frac{p}{2}\right)} + D_{t+\left(\frac{p}{2}\right)} + \sum_{i=t+1-\left(\frac{p}{2}\right)}^{t-1+\left(\frac{p}{2}\right)} 2D_i \right]}{(2p)} & \text{for } p \text{ even} \\ \dfrac{\sum_{i=t-\left\lfloor \frac{(p-1)}{2} \right\rfloor}^{t+\left\lfloor \frac{(p-1)}{2} \right\rfloor} D_i}{p} & \text{for } p \text{ odd} \end{cases}$$

Estimate Level and Trend (cont.)

$$\overline{D}_t = \frac{\left[D_{t-\left(\frac{p}{2}\right)} + D_{t+\left(\frac{p}{2}\right)} + \sum_{i=t+1-\left(\frac{p}{2}\right)}^{t-1+\left(\frac{p}{2}\right)} 2D_i \right]}{(2p)}$$

$$= \frac{D_1 + D_5 + \sum_{}^{4}}{}$$

Tahoe Salt (cont.)

	A	B	C
1	*Period* *t*	*Demand* D_t	*Deseasonalized Demand*
2	1	8,000	
3	2	13,000	
4	3	23,000	19,750
5	4	34,000	20
6	5	10,000	
7	6	18,000	
8	7	23,00	
9	8		
10	9		
11	10		
12			
13			

Cell	

Figure 7-2 Excel Workbook with Deseasonalized Demand for Tahoe Salt

Tahoe Salt (cont.)

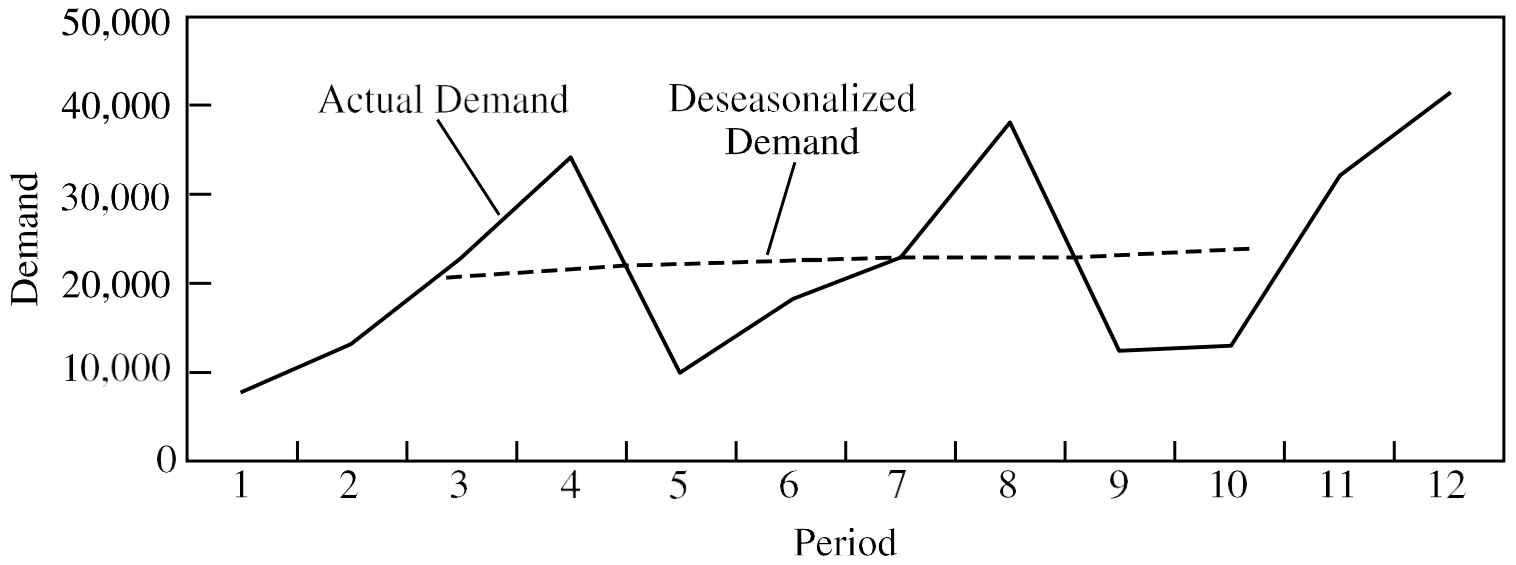


Figure 7-3 Deseasonalized Demand for Tahoe Salt

A linear relationship exists between the deseasonalized demand and time based on the change in demand over time

$$\bar{D}_t = L + T_t$$

Estimating Seasonal Factors for Tahoe Salt

$$S_i = \frac{\sum_{j=0}^{r-1} \bar{S}_{jp+i}}{r}$$

$$S_1 = \frac{(\bar{S}_1 + \bar{S}_5 + \bar{S}_9)}{3} = \frac{(0.42 + 0.47 + 0.52)}{3} = 0.47$$

$$S_2 = \frac{(\bar{S}_2 + \bar{S}_6 + \bar{S}_{10})}{3} = \frac{(0.67 + 0.83 + 0.55)}{3} = 0.68$$

$$S_3 = \frac{(\bar{S}_3 + \bar{S}_7 + \bar{S}_{11})}{3} = \frac{(1.15 + 1.04 + 1.32)}{3} = 1.17$$

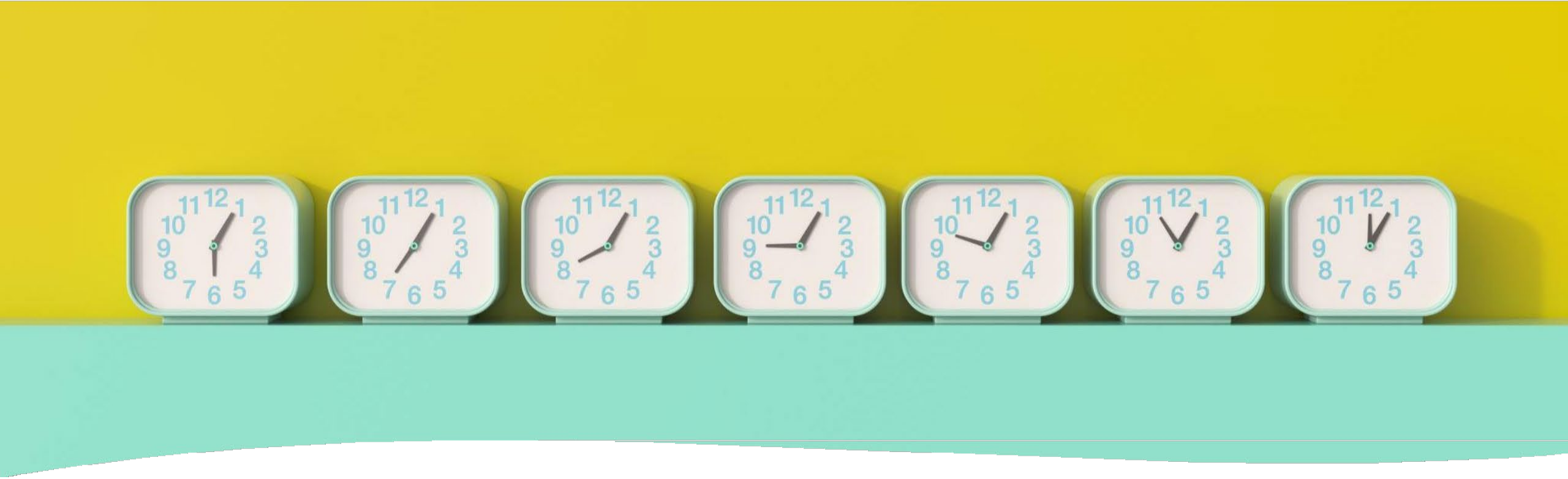
$$S_4 = \frac{(\bar{S}_4 + \bar{S}_8 + \bar{S}_{12})}{3} = \frac{(1.66 + 1.68 + 1.66)}{3} = 1.67$$

$$F_{13} = (L + 13T)S_{13} = (18{,}439 + 13 \times 524)0.47 = 11{,}868$$

$$F_{14} = (L + 14T)S_{14} = (18{,}439 + 14 \times 524)0.68 = 17{,}527$$

$$F_{15} = (L + 15T)S_{15} = (18{,}439 + 15 \times 524)1.17 = 30{,}770$$

$$F_{16} = (L + 16T)S_{16} = (18{,}439 + 16 \times 524)1.67 = 44{,}794$$



Time-Series Forecasting - Naïve Forecast

- **Naïve forecast**
  - Uses a single previous value of a time series as the basis for a forecast
  - Can be used with
    - A stable time series: FC = previous time period value
    - Trend: FC = last value of the series +/- difference between last two values
    - Seasonal variations: use of the two above

Time-Series Forecasting - Averaging

- These techniques work best when a series tends to vary about an average
  - Averaging techniques smooth variations in the data
  - Minor variations treated as random variations
  - They can handle step changes or gradual changes in the level of a series
  - Techniques
    1. Moving average
    2. Weighted moving average
    3. Exponential smoothing

Moving Average

- Technique that averages a number of the most recent actual values in generating a forecast

$$F_t = \text{MA}_n = \frac{\sum_{i=1}^{n} A_{t-i}}{n} = \frac{A_{t-n} + \ldots + A_{t-2} + A_{t-1}}{n}$$

where

F_t = Forecast for timeperiod t

MA_n = n period moving average

A_{t-i} = Actual value in period $t - i$

n = Number of periods in the moving average

Weighted Moving Average

- The most recent values in a time series are given more weight in computing a forecast
  - The choice of weights, *w*, is somewhat arbitrary and involves some trial and error

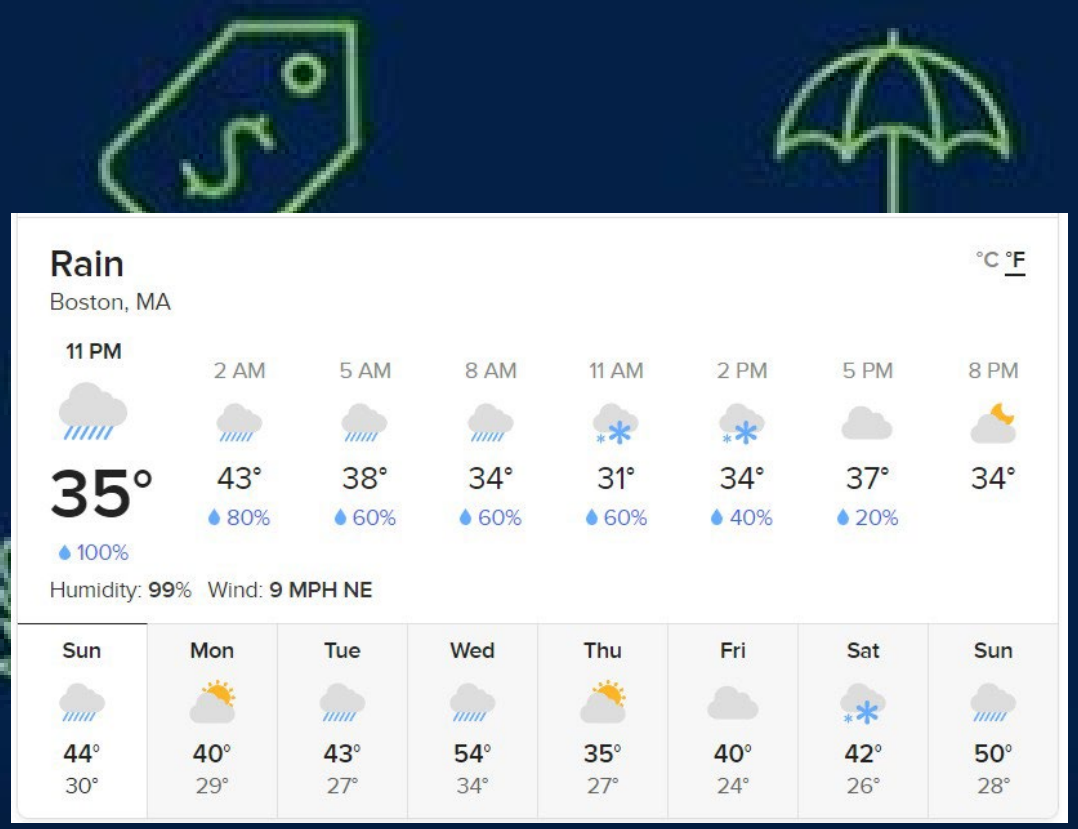
$$F_t = w_t(A_t) + w_{t-1}(A_{t-1}) + \ldots + w_{t-n}(A_{t-n})$$

where

$w_t = \text{weight for period } t,\ w_{t-1} = \text{weight for period } t-1, \text{ etc.}$

$A_t = \text{the actual value for period } t,\ A_{t-1} = \text{the actual value for period } t-1, \text{ etc.}$

IBM-SAP demand forecasting



- Read in the news: https://www.forbes.com/sites/ibm/2019/11/27/the-science-of-ibms-holiday-retail-forecast-and-why-companies-count-on-it/#6e4418fca248
- Watch: https://www.youtube.com/watch?v=vl15KgRUdyI
- Think about
  - How do weather related forecasts predict buyer behavior?
  - What other factors are considered in IBM's holiday forecasting models for retailers? What has helped improve their accuracy in recent years?

Exponential Smoothing

- A weighted averaging method that is based on the previous forecast plus a percentage of the forecast error

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

where

F_t = Forecast for period t

F_{t-1} = Forecast for the previous period

α = Smoothing constant

A_{t-1} = Actual demand or sales from the previous period

Year	Enrollment
1	1900
2	2300
3	2800
4	3300

Month	Number o Visi
April	
May	
June	
July	
Aug	

Naïve, MA, WA, expo FC examples

class examples MAD MSE MAPE week 2.xlsx

https://oneeducatorsopinion.wordpress.com/2014/02/26/brain-breaks-are-good-for-teachers-too/

Forecast Accuracy and Control

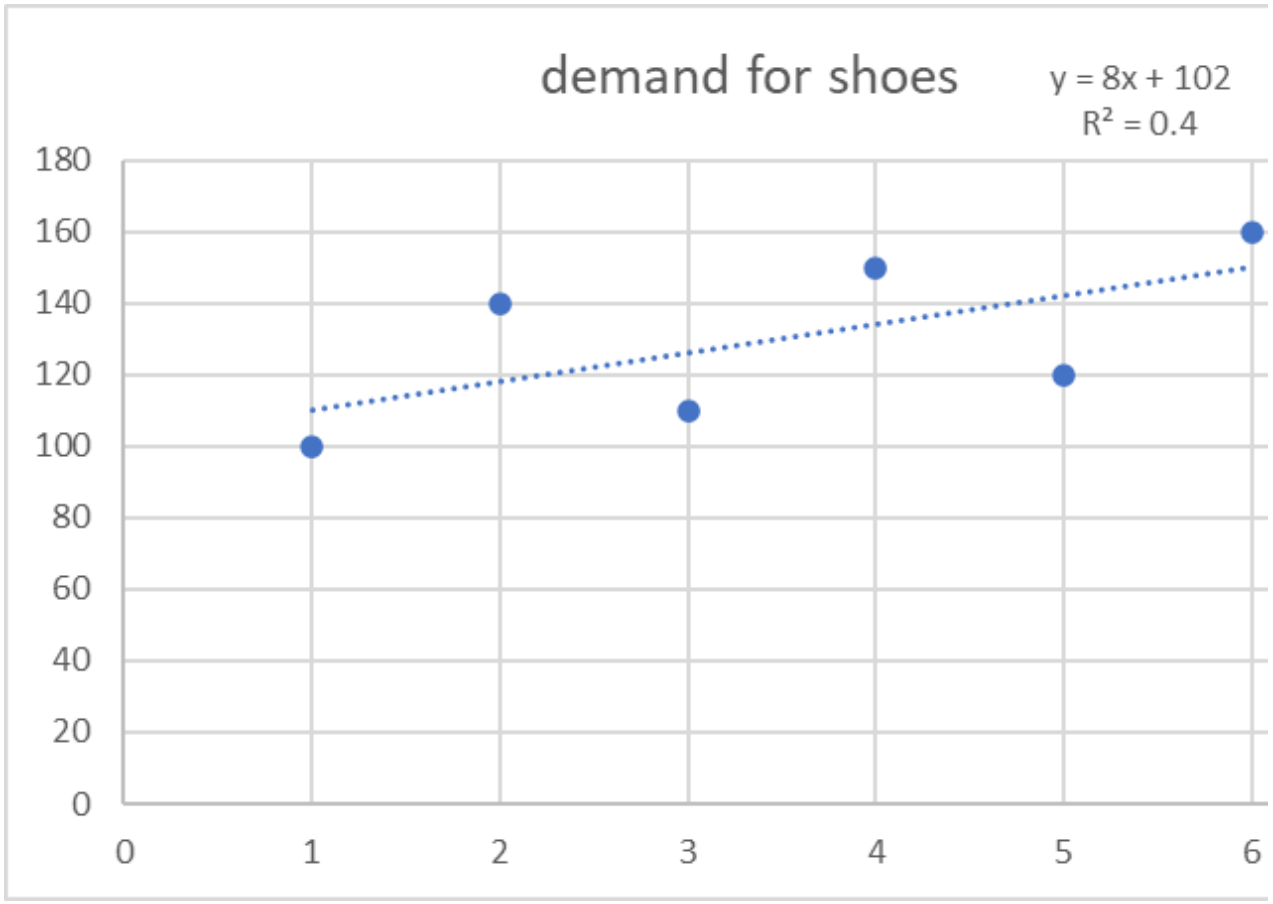
Allowances should be made for forecast errors

- It is important to provide an indication of the extent to which the forecast might deviate from the value of the variable that actually occurs

Forecast errors should be monitored

- Error = Actual – Forecast
- If errors fall beyond acceptable bounds, corrective action may be necessary

https://www.seekpng.com/ipng/u2e6a9y3o0e6r5a9_error-icon-download-attention-symbol/



How good is my linear trend?

- r^2, square of the correlation coefficient
  - A measure of the percentage of variability in the values of y that is "explained" by the independent variable
  - Ranges between 0 (no correlation) and 1.00 (perfect correlation)

Forecast Accuracy Metrics

$$\text{MAD} = \frac{\sum |\text{Actual}_t - \text{Forecast}_t|}{n}$$

MAD = mean absolute deviation
weights all errors evenly

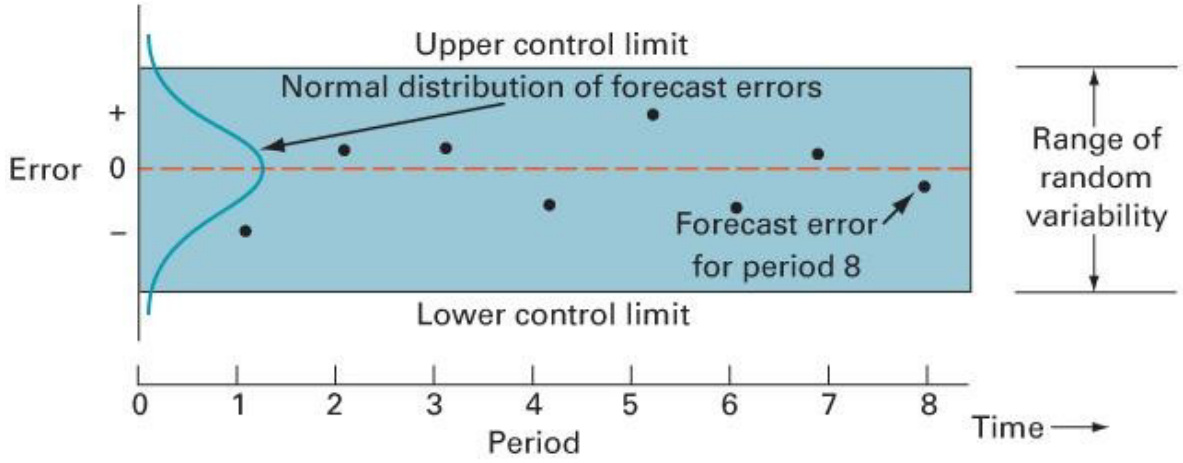
$$\text{MSE} = \frac{\sum (\text{Actual} - \text{Fo}}{}$$

MSE = mean squared error
weights errors according to their squared values

$$\text{MAPE} = \frac{\sum \frac{|\text{Actual}_t - \text{Forecast}_t|}{\text{Actual}_t} \times 100}{n}$$

MAPE = mean absolute percent error
weights errors according to relative error

Control Chart Construction for monitoring forecasts

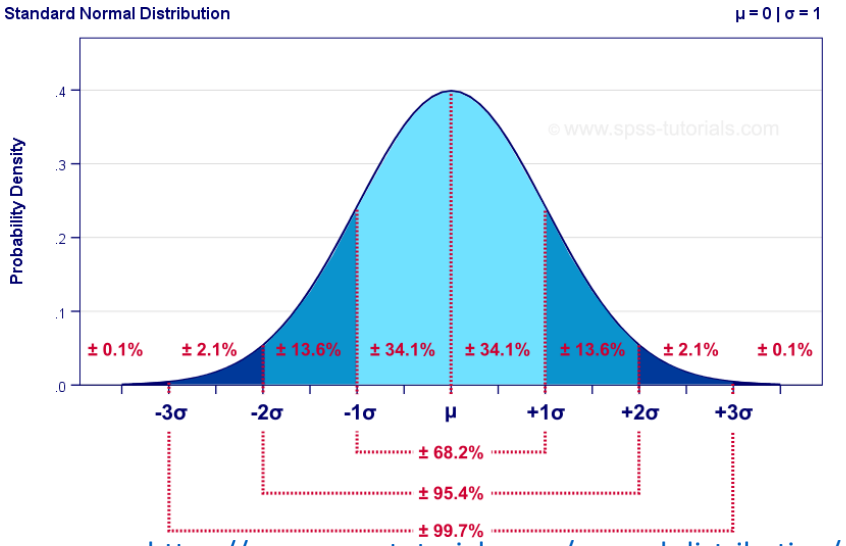


1. Compute the MSE.
2. Estimate of standard deviation of the distribution of errors

$$s = \sqrt{\text{MSE}}$$

3. $\text{UCL} : 0 + z\sqrt{\text{MSE}}$
4. $\text{LCL} : 0 - z\sqrt{\text{MSE}}$

where z = Number of standard deviations from the mean



https://www.spss-tutorials.com/normal-distribution/

FC Accuracy Examples in Excel

Blueberry Muffins	naïve	3 WA	expo .5
30			
34	30		30.0
32	34		32.0
34	32	32.0	32.0
35	34	33.3	33.0
30	35	33.7	34.0
34	30	33.0	32.0
36	34	33.0	33.0
29	36	33.3	34.5
31	29	33.0	31.8
35	31	32.0	31.4
31	35	31.7	33.2
37	31	32.3	32.1
34	37	34.3	34.5
33	34	34.0	34.3

class examples MAD MSE MAPE week 2.xlsx

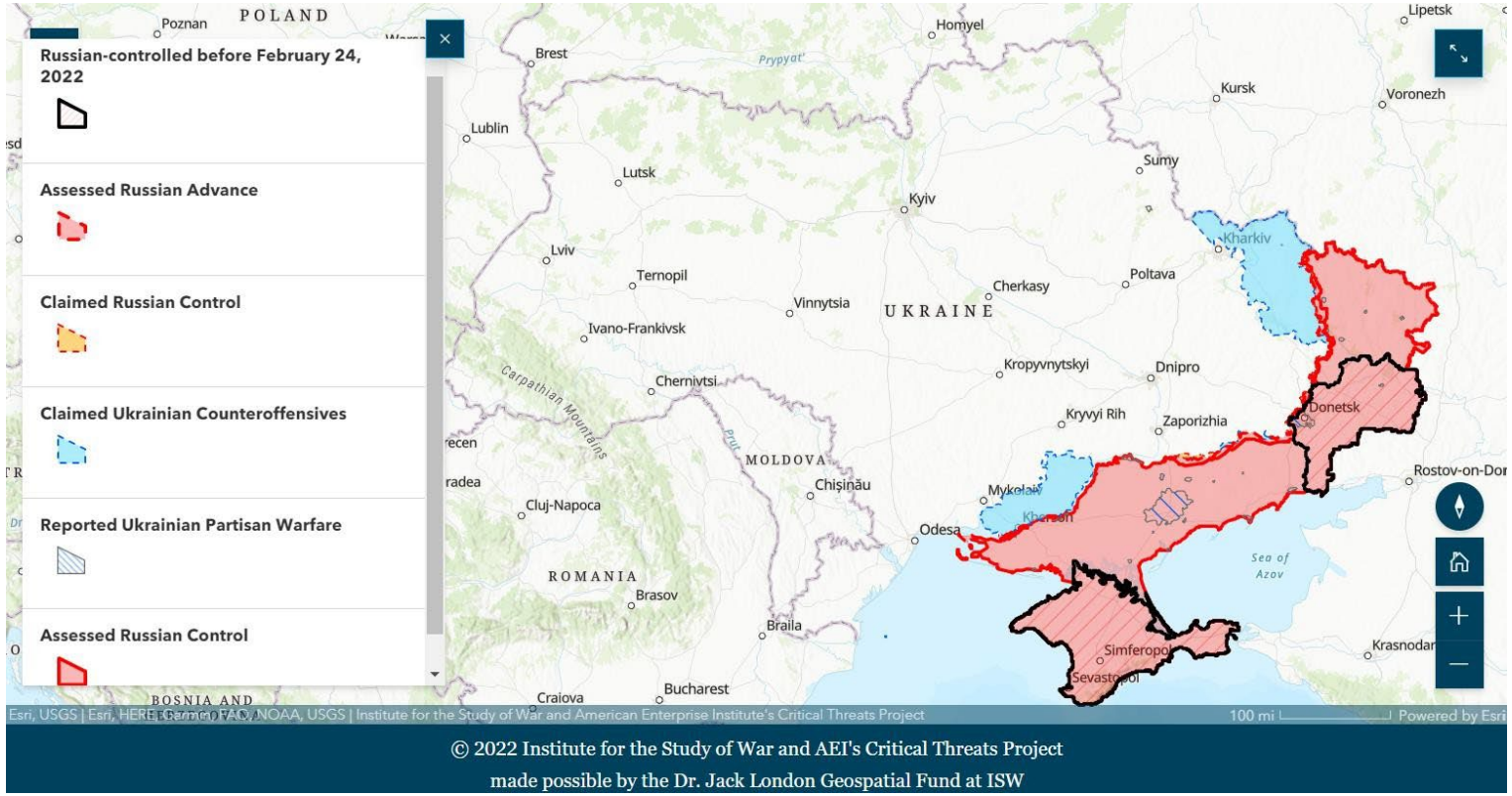
Choosing a Forecasting Technique

- Factors to consider
  - Cost
  - Accuracy
  - Availability of historical data
  - Availability of forecasting software
  - Time needed to gather and analyze data and prepare a forecast
  - Forecast horizon

From Indiana Jones and the Last Crusade

Ukraine case study (teams)

- Pick a commodity to research
- Report:
  - Discuss the disruption of the global supply chains and trade of the commodity chosen caused by the war in Ukraine
  - Define the supply chain (diagram with narrative) pre-war and currently. Who are the players?
  - What is the impact? (local/global)
  - What risk mitigation could firms take in advance or during such a disruption? How have firms responded to the disruption? What type of data is required to analyze risks or trigger a supply chain risk response?
  - 4-5 pages doubled spaced including tables/diagrams/ narrative; include all referenced works. Due 2/9.



- References posted on BB
  - LSE Expertise: Ukraine and the global response
  - KPMG white paper on the impact of Russia's invasion of Ukraine on the global economy
  - Global economic consequences of the war in Ukraine
  - Russia-Ukraine conflict and its implications on global food supply chains

Teams for Ukraine case study

name	Ukraine teams
Alfaro, Marugenia	1
Beisecker, Kelsey	1
Dizon, Ric	1
Ghazaryan, Shushanik	1
Ahadiat, Parisa	2
Bui, Cindy	2
Euceda Iscoa, Marlon	2
Gonzalez-Aguayo, Gisela	2
Alramahi, Ehab	3
Collier, Nicole	3
Freeman, Annie	3
Guelff, Michelle	3
Ang, Paul	4
Contreras, Stephanie	4
Galleta, Beda	4
Han, Chris	4

name	Ukraine teams
Kariuki, Janet	5
Lopez, Ruben	5
Perez, Melissa	5
Sampson, Ivy	5
Joshua, Jonathan	6
Magallon, Dominick	6
Ramirez, Lizbeth	6
Vidovich, Mikaela	6
Khachatryan, Marieta	7
Matthews, Olivia	7
Redfearn, Joe	7
Wand, Kelly	7
Khafajizadeh, Bina	8
Nguyen, Jessica	8
Rodgers, Samuel	8
Weiss-Varela, Samantha	8

RED = team leader for this assignment

Assignment week 2

- Homework 1. Due before next class
  - Chapter 7, forecasting
    - What problem have you seen personally from poor demand forecasting? What could have been done to improve it?
    - Page 200-201, exercises:
      - 1 using static seasonal (no bias, TS)
      - 2 using static naïve, WA, expo, linear (no bias, TS)

        5
      - 8 using static WA, expo (no bias, TS)