

Forecasting

- **Introduction**
 - What do we have to do?
 - How many do we need?
 - Decisions are made under uncertainty
 - Good forecasts reduce uncertainty
 - Forecasts are the basis of planning
- **Information Requirements – Depend on:**
 - Timeframe of interest (time of decision)
 - Level of detail
 - Low for long range planning
 - High for short-range decisions

Important Principles of Forecasting

- **Forecasts are part of decision making**
 - Inventory control
 - Capacity and Facility Location
 - Manpower requirements
- **Forecasts are always wrong!**
 - Based on:
 - Past information
 - Guesses about the future
 - Systems designs must be flexible
 - Respond to changes in the environment
 - Respond to updated forecasts

Important Principles

(continued)

- **Choose method to fit need**
 - **Time vs. Level of detail (avoid Type IV error)**
 - **Use simplest method possible**
 - **Use simple models as sanity check on complicated models**
- **Forecast is often confused with a goal**
 - **Examples:**
 - **Sales forecasts sometimes biased high when given to salemen (make them work harder)**
 - **Forecasts biased low when given to management (want to exceed expectations)**

Forecasting Techniques – 4 types

- (1) **Judgement – all methods require some judgement**
 - **All judgement methods suffer from human failings**
 - **Squeaky Wheel effect**
 - **Personal biases**
 - **Inability to handle large amounts of data**
 - **Methods**
 - BFE**
 - SWAG**
 - i.e., use of expert opinion, intuition, and experience, or brainstorming**
 - **Formal methods**
 - Delphi Method**
 - Analytical Hierarchy Process (AHP)**
 - Often slow and cumbersome**
 - Hard for short and midterm forecasts**

Use of Judgment in Forecasts

Disagreement exists

Experiments by Lawrence (1983) show that some judgmental methods beat "Black Box" mathematical techniques

Carbone (1983) showed that judgemental adjustment doesn't help the accuracy of forecasts made statistically

BOTTOM LINE: Combination of judgement and statistical forecasts is probably best. *Use common sense.*

Forecasting Techniques – 4 types

(2) Counting Methods

- Survey of potential customers
- Find out how many people will buy goods or use services
- Often a marketing function
- Census – count of entire population
- Sample – count a portion of population and make inference about the whole population

Note: Survey results are time sensitive

- example – During recession
- Remodeling went up
- Real estate sales went down

Forecasting Techniques – 4 types

(3) Time Series

- Draw inference from past demand history

WARNING: These methods assume that future will look like the past

- Bad for new situations or new factors

- Methods

Moving Average

Weighted Moving Average

Exponential Smoothing

Other more complicated methods (Box–Jenkins)

Vocabulary of Time Series

Trend – gradual upward or downward movement of the data over time

Seasonality – demand fluctuation pattern above and below the trend line occurring every year*

Cycles – patterns that occur in the data every several years (reflect business cycles)

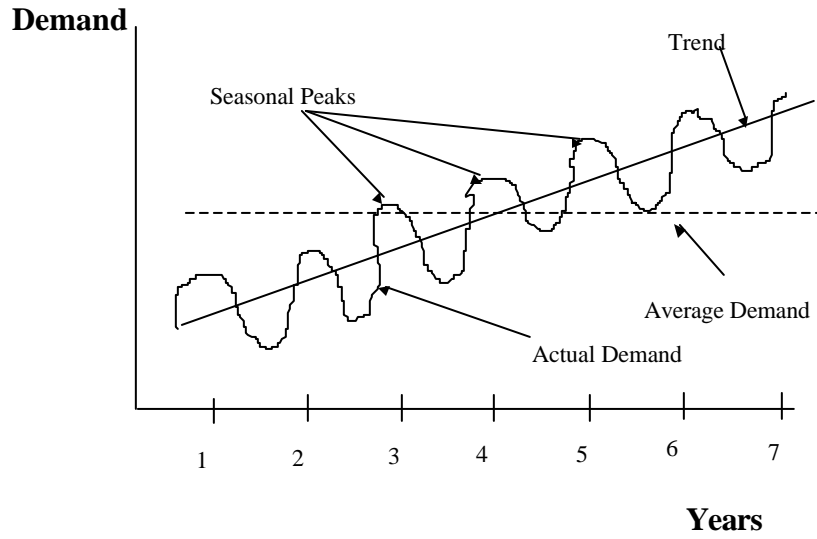
Random Variations – chance variation in the data

- no pattern
- like error in statistical model

* not limited to years

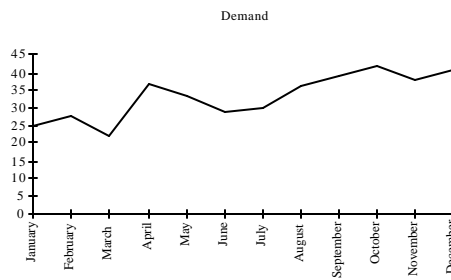
example – business at the bank with seasonal effects around mid and end of month paydays

Time Series



Moving Average Example

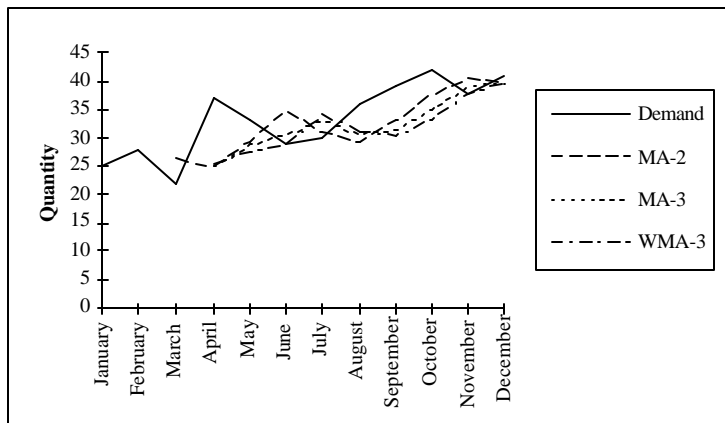
Period	Demand
January	25
February	28
March	22
April	37
May	33
June	29
July	30
August	36
September	39
October	42
November	38
December	41



Moving Average Example (continued)

Period	Demand	MA-2	MA-3	WMA-3
January	25			
February	28			
March	22	26.500		
April	37	25.000	25.000	25.500
May	33	29.500	29.000	27.500
June	29	35.000	30.667	28.833
July	30	31.000	33.000	34.333
August	36	29.500	30.667	31.167
September	39	33.000	31.667	30.500
October	42	37.500	35.000	33.500
November	38	40.500	39.000	38.000
December	41	40.000	39.667	39.833

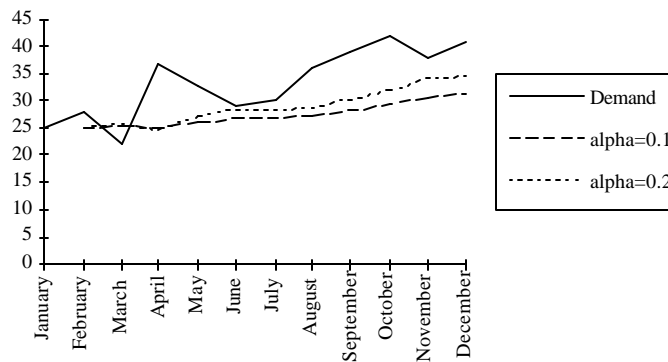
Moving Average Example (continued)



Exponential Smoothing

Period	Demand	MA-2	MA-3	WMA-3	Exp Smooth alpha=0.1	Exp Smooth alpha=0.2
January	25					
February	28				25.000	25.000
March	22	26.500			25.300	25.600
April	37	25.000	25.000	25.500	24.970	24.880
May	33	29.500	29.000	27.500	26.173	27.304
June	29	35.000	30.667	28.833	26.856	28.443
July	30	31.000	33.000	34.333	27.070	28.555
August	36	29.500	30.667	31.167	27.363	28.844
September	39	33.000	31.667	30.500	28.227	30.275
October	42	37.500	35.000	33.500	29.304	32.020
November	38	40.500	39.000	38.000	30.574	34.016
December	41	40.000	39.667	39.833	31.316	34.813

Exponential Smoothing (continued)



Mean Absolute Deviation

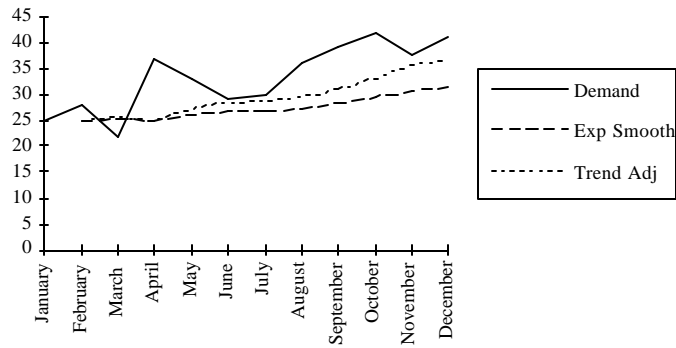
Period	Demand	MA-2	MAD MA-2	Exp Smooth alpha=0.1	MAD Exp Smooth
January	25				
February	28			25.000	
March	22	26.500	4.5	25.300	3.300
April	37	25.000	12	24.970	12.030
May	33	29.500	3.5	26.173	6.827
June	29	35.000	6	26.856	2.144
July	30	31.000	1	27.070	2.930
August	36	29.500	6.5	27.363	8.637
September	39	33.000	6	28.227	10.773
October	42	37.500	4.5	29.304	12.696
November	38	40.500	2.5	30.574	7.426
December	41	40.000	1	31.316	9.684
Total			47.5		76.447
MAD			4.75		7.645

Trend Adjustment

(Second Order Smoothing)

Period	Demand	Exp Smooth alpha=0.1	Trend beta=.9	Adj Forecast alpha=0.1
January	25			
February	28	25.000	0.000	25.000
March	22	25.300	0.270	25.570
April	37	24.970	-0.027	24.943
May	33	26.173	1.056	27.229
June	29	26.856	1.670	28.526
July	30	27.070	1.863	28.933
August	36	27.363	2.127	29.490
September	39	28.227	2.904	31.131
October	42	29.304	3.874	33.178
November	38	30.574	5.016	35.590
December	41	31.316	5.685	37.001

Trend Adjustment (continued)



Trend Adjustment (continued)

Period	Demand	MA-2	MAD MA-2	Exp Smooth alpha=0.1	MAD Exp Smooth	Adj Forecast alpha=0.1	MAD Adj Forecast
January	25						
February	28			25.000		25.000	
March	22	26.500	4.5	25.300	3.300	25.570	3.570
April	37	25.000	12	24.970	12.030	24.943	12.057
May	33	29.500	3.5	26.173	6.827	27.229	5.771
June	29	35.000	6	26.856	2.144	28.526	0.474
July	30	31.000	1	27.070	2.930	28.933	1.067
August	36	29.500	6.5	27.363	8.637	29.490	6.510
September	39	33.000	6	28.227	10.773	31.131	7.869
October	42	37.500	4.5	29.304	12.696	33.178	8.822
November	38	40.500	2.5	30.574	7.426	35.590	2.410
December	41	40.000	1	31.316	9.684	37.001	3.999
		Total	47.5		76.447		52.549
		MAD	4.75		7.645		5.255

Forecasting Techniques – 4 types

(4) Causal Forecasting

– Regression Analysis

– Trend analysis uses time as the independent variable in the regression

– Other quantities can be used as well

ex. Demand for heating oil = $f(\text{temperature})$

Sales = $f(\text{local payroll})$

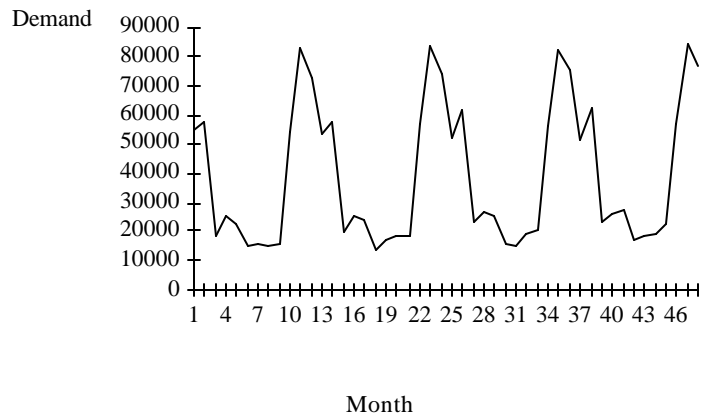
Real estate sales = $f(\text{mortgage interest rate})$

Example

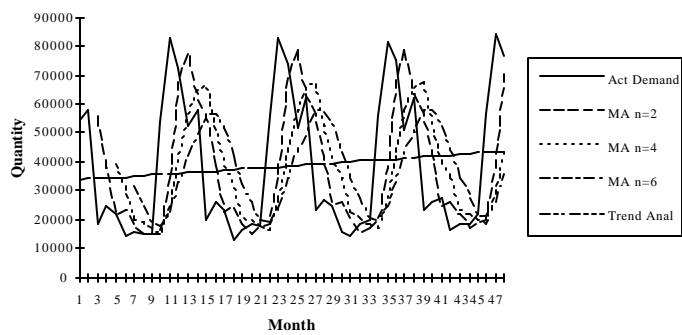
Actual Demands

Month	Year 1	Year 2	Year 3	Year 4
1	54525	52978	52066	51141
2	58142	58145	61921	62647
3	18362	19756	23249	23278
4	25429	25975	27083	26150
5	22322	23720	25072	27445
6	14617	13376	15598	16579
7	15534	16609	14807	18261
8	15108	18359	18969	18627
9	15408	18124	20202	22084
10	53918	56279	56149	56868
11	83188	83298	82176	84064
12	72913	74194	75539	76531
TOTAL	449466	460813	472831	483675
Avg Monthly	37455.5	38401.08333	39402.58333	40306.2

Example (continued)



Example (continued)



Seasonal Adjustments

Month	Year 1	Year 2	Year 3	Year4	Averag
1	1.456	1.380	1.321	1.269	1.3563
2	1.552	1.514	1.571	1.554	1.5480
3	0.490	0.514	0.590	0.578	0.5430
4	0.679	0.676	0.687	0.649	0.6728
5	0.596	0.618	0.636	0.681	0.6327
6	0.390	0.348	0.396	0.411	0.3864
7	0.415	0.433	0.376	0.453	0.4190
8	0.403	0.478	0.481	0.462	0.4562
9	0.411	0.472	0.513	0.548	0.4859
10	1.440	1.466	1.425	1.411	1.4352
11	2.221	2.169	2.086	2.086	2.1403
12	1.947	1.932	1.917	1.899	1.9236

Values obtained by dividing actual demand by yearly average

Trend Analysis Seasonally Adjusted

